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EVAPORATION RATES OF CHEMICAL WARFARE AGENTS USING 5 CM WIND TUNNELS IV. VX FROM GLASS

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The evaporation of VX from glass was studied as a function of temperature, drop size, and air flow rate, using the same instrumentation as prior studies of sulfur mustard evaporation from glass, concrete, and sand. The evaporation rate increased with higher temperature and drop size; wind speed was not a significant factor. An empirical equation was determined that would allow for the calculation of the evaporation rate given the atmospheric conditions. The data collected provide input for the validation of empirical and physics-based models on the evaporation of agent designed by other authors, and are input for the VLSTRACK model, which predicts agent vapor concentrations as a function of environmental conditions.

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PREFACE

The work described in this report was authorized under Contract No. DAAD13-03-D-0017. The work began in August 2006 and was completed in September 2009.

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EVAPORATION RATES OF CHEMICAL WARFARE AGENTS USING 5 CM WIND TUNNELS IV. VX FROM GLASS

1. INTRODUCTION

The evaporation rates of the chemical warfare agent sulfur mustard from glass, concrete, and sand as a function of temperature, drop size, and air flow rate have been previously reported.[1,2,3] Select evaporation and degradation rates of ton container VX on sand and glass have also been reported in the literature.[4] In this work, additional evaporation data for VX on the same glass, as used previously, as a function of temperature, drop size, and air flow rate measured in 5 cm wind tunnels are presented. This report describes the data analysis and demonstrates the robustness of the set of data that will be passed to the modelers for eventual incorporation into field models such as VLSTRACK, which predicts vapor concentration as a function of environmental conditions.

2. EXPERIMENTAL PROCEDURES

2.1 Wind Tunnel

The 5 cm wind tunnels that were used in the present investigations have been previously described and were the same as those used for similar earlier studies on glass.[5] The design of the 5 cm laboratory-sized wind tunnels[6] and the wind tunnel characteristics compared to other wind tunnels and outdoors measurements have been published.[7,8] In order to expose the agent to the wind flow, the piston was removed and the test substrate (a 1.5 in. diameter circle) with the droplet of agent on it was placed onto the piston and inserted into the wind tunnel. The humidified, temperature-controlled air from a Miller-Nelson Environmental Control Unit (ECU) (tunnel a) or an Aalborg MFC (tunnels c, d, k, l) was then passed over the sample and the vapors were collected on Markes Tenax® thermal desorption tubes (Agilent Technologies, Santa Clara, CA) at the vapor sampling inlet. The amount of agent on each tube was measured based upon a standard in the Gas chromatography/Mass Spectrometry (GC/MS). The sample volume and tunnel air flow rate were known; thus, the agent concentration (mg/m^3) and evaporation rate (µg/min) could be calculated. The rates were not calculated for the initial 5 min of the experiment (before the instrumentation reached equilibrium) nor at the end of the experiment (when concentration of mustard was nearing a plateau due to sample exhaustion). Hence, the data in the middle of each experimental run were used to calculate the evaporation rates.

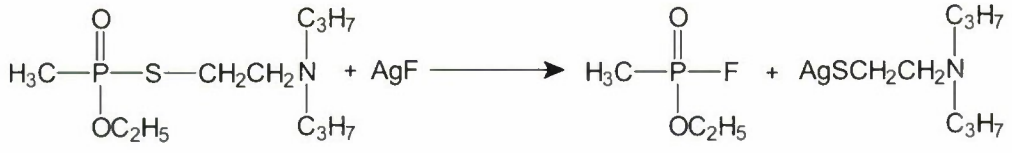
Air flows were 18, 181, and 405 standard liters per minute (SLPM), which corresponded to velocity values at a 1 cm height of 0.22, 1.7, and 3.6 m/s. The flow volume per thermal desorption tube was typically 2 to 10 L volume, and the tubes were automatically switched using a proprietary Versatile Tube Sampler. The rate at which the tubes were switched was adjusted based upon the evaporation rate of the agent. The air and substrate temperatures investigated in this work were 35, 42, and 50 °C, and the droplet sizes were 1, 6, and 9 µL, corresponding to droplet diameters of 1.24, 2.25, and 2.58 mm and contamination densities of

approximately 1.3, 7, and 11 g/m^2. The droplets masses used in the calculations and tables were based upon the pipette setting; the samples were not weighed.

In general, the evaporation of the VX was measured until no further decrease in the concentration of vapor was detected at which time the experiment was terminated. Summation of the concentrations over time yielded the cumulative amount of VX that had evaporated. The data collected are shown in the Appendix.

2.2 Detection of VX in the Wind Tunnel Effluent

For the analysis of VX, a silver fluoride pad (CAMSCO, Houston, TX) was inserted onto the end of Tenax TA thermal desorption tubes (Markes International, Llantrisant, UK) to convert any VX in the stream to its G-analog, ethyl methylphosphonofluoridate (EMPF, EA-1207) which is more volatile and therefore easier to analyze by thermal desorption GC. The chemical equation for the reaction is shown in Scheme 1.



Scheme 1. V-to-G Conversion on Silver Fluoride Pads.

The ethyl methylphosphonofluoridate was desorbed from the thermal desorption tubes using a Markes UNITY/ULTRA Desorption system (Markes International, Llantrisant, UK), and analyzed on an Agilent 6890/5973 Gas Chromatography/Mass Spectrometry Detector (GC/MSD [Agilent Technologies, Santa Clara, CA]) using a HP-5MS capillary column (30 m long, 0.25 mm id, 0.25 µm film thickness, (5%-phenyl)-methylpolysiloxane stationary phase).[9] Oven parameters were 60 (1.5 min) to 250 °C at 50 °C/min. Thermal desorber parameters were a tube desorption temperature of 250 °C for 2.5 min and a 10 mL/min split flow. The tube purge/sweep flow was 50 mL/min, the trap desorption temperature was 300 °C for 2.0 min. The sample was carried into a split/splitless injection port at 250 °C. The split vent was turned on at 0.5 min with a purge flow of 50 mL/min of helium. Retention times were 1 min for ethyl methylphosphonofluoridate, 2.1 min for the internal standard bromofluorobenzene, and 3.4 min for 3-hydroxymandelic acid, ethyl ether (impurity, not from VX) (Figure 1). The mass spectrometer was operated in Electron Ionization (EI) mode and scanned from 35-300 amu in 2.78 s. The molecular ion for ethyl methylphosphonofluoridate (m/z = 126) was not typically observed, but the characteristic fragment ion at m/z = 99 was observed (Figure 2).

The ability of the Tenax TA tubes to collect the VX vapor was verified by injecting a known amount of VX vapor into a 20 ft copper tube that had flowing air and showed that the VX was quantitatively recovered.

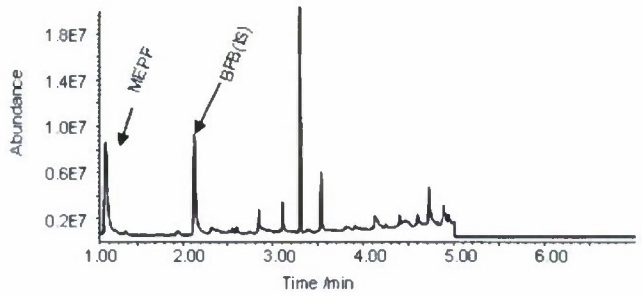


Figure 1. Retention Times of Ethyl Methylphosphonofluoridate (MEPF), 1 min, Internal Standard Bromofluorobenzene (BFB), 2.1 min, and Hydroxymandelic Acid, Ethyl Ether, 3.4 min.

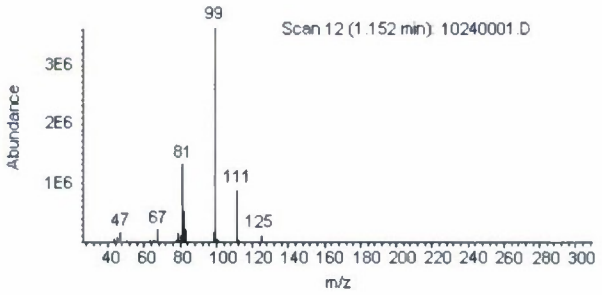


Figure 2. Mass Spectrum of the 1.1 min Ethyl Methylphosphonofluoridate Peak.

2.3 Analysis of Neat Ton Container VX

Two samples were prepared for analyses by GC/MSD. The first sample was prepared by adding 2 µL VX to 200 µL of acetonitrile. From this dilute mixture, a 10 µL aliquot was further diluted into 0.6 mL of methylene chloride, which was analyzed by GC/MS, of which 1 µL was injected onto the GC/MS. The compounds of interest detected were 2-(diisopropylamino)ethanol, 12.1 min; diethyl dimethylpyrophosphonate, 16.2 min; VX, 20.0 min; and bis(diisopropylaminoethyl) disulfide, 23.5 min.

The second sample was prepared by adding 2 µL BSTFA and 2 µL VX to 200 µL acetonitrile. The mixture was then heated at 60 °C for 20 min. After the heating period, 10 µL of the derivatized mixture were added to 0.6 mL of methylene chloride and the resulting solution (1 µL) was analyzed by GC/MS. Compounds of interest detected were trimethylsilyl (TMS)-derivatized-ethyl methylphosphonic (EMPA) acid, 11.5 min; 2-(diisopropylamino)ethanol, 12.1 min; TMS-derivatized-ethyl methylphosphonothioic (EMPT) acid, 12.4 min;

S-trimethylsilyl-2-(diisopropylamino)ethanol, 16.0 min; diethyl dimethylpyrophosphonate, 16.2 min; VX, 20.0 min and bis(diisopropylaminoethyl) disulfide 23.5 min.

2.4 Experimental Design and Data Analysis

The data were analyzed using JMP® Statistical Discovery Software. The three variables were temperature, drop size, and air flow rate at three levels each. Measuring all combinations of these levels would yield 27 conditions (3 x 3 x 3); the cubic composite design chosen required nine conditions, which can be described as the vertices of a cube and the cube's center. This collection of data allowed for the determination of the major contributing variables and interactions among variables, although in this particular study, not all of the data points in the experimental design were collected due to the length of time of each experiment. The substrate temperature (°C), droplet mass (mg), air flow (SLPM), total percent VX recovered, and tunnel identity (four similar 5 cm tunnels, named a, e, k and l, were available) were treated as variables that may affect the raw evaporation rate. Effect interactions among droplet mass, air flow, and temperature were included in the numerical analysis.

3. RESULTS

3.1 Time to Plateau

The VX vapor was collected until the concentration of agent reached a plateau, often ~1 x 10^{-4} mg/m^3. The lowest detected vapor concentration was 2 x 10^{-6} mg/m^3 (Figure 3). Only the 50 °C, 0.92 µL, 405 SLPM samples consistently gave vapor values of zero. The trend in the time taken to reach a plateau is shown in the cube plot in Figure 4. For many samples, the concentration at this time was near the short-term exposure limit (STEL required by the Occupational Safety and Health Administration [OSHA]) of 1 x 10^{-5} mg/m^3.[10] A least squares regression (r^2 = 0.94, r_{adj}^2 = 0.91)[a] showed that the significant factors were temperature, drop size (in mg), air flow, %VX recovered, tunnel 'a', and mass * air flow (Figure 5, Table 1). The equation generated was

Time to plateau = 6315 - 107*T + 145 * drop mass - 2.2 * air flow -7.2 * %VX recovered - 914 * tunnel[a] – 0.42 * {(drop mass - 4.3) * (air flow - 223)} (1)

3.2 Percentage Recovery

Scatterplots of the variables substrate temperature (°C), droplet mass (mg), and air flow (SLPM), and the results %VX recovered and raw evaporation rate showed that the %VX recovered and raw evaporation rate were loosely correlated with each other (r = 0.64,[b] Figure 6). None of the other parameters were correlated. In fact, the data showed that the %VX recovered and raw evaporation rate data were distributed throughout their respective ranges as a function of

[a] r^2 estimates the proportion of the variation that can be attributed to the model rather than to random error; r_{adj}^2 adjusts for models that have different numbers of parameters. A perfect fit is r = 1.0. JMP Statistics and Graphics Guide, Version 5, by SAS Institute, Cary, NC, 2002, p186.

[b] r is the Pearson Product-Moment correlation; a perfect fit is r = 1.0. JMP Statistics and Graphics Guide, Version 5, by SAS Institute, Cary, NC, 2002, p376.

temperature, drop mass, and air flow. A cube plot also shows the ranges in %recovery (Figure 7). The percentage of agent recovered was largely random; the least squares regression had a low correlation coefficient ($r^2 = 0.58$, $r_{adj}^2 = 0.37$, Figure 8).

3.3 Evaporation Rates

The evaporation rate was calculated by summing the %VX vapor recovered, plotting the cumulative %VX loss versus time, and taking the slope of the line, which was the evaporation rate (Figure 9). Examples of replicate collections of evaporation data at two different conditions demonstrate the degree of variability observed (Figure 10).

Given the large degree of variability in the raw evaporation rate (Table 2), the raw evaporation rates were divided by the %VX recovered to yield an adjusted evaporation rate. Organizing the data by condition and taking the averages showed that the adjusted evaporation rates covered a much smaller range than the raw evaporation rates, and major trends began to emerge, as shown in a cube plot (Figure 11, Table 2).

Numerical analysis of the data was performed – namely, using a least squares fit for the raw evaporation rates (mg/min) as a function of substrate temperature (°C), droplet mass (mg), air flow (SLPM), %VX recovered, tunnel identity and the interacting factors, temperature * mass, temperature * air flow and mass * air flow(Figure 12, Table 3). The r^2 was 0.90; r_{adj}^2 was 0.87, and the statistically significant factors were temperature, droplet mass (in mg), % agent recovered, temperature * air flow and drop mass * air flow; 40 datapoints were used. Tunnels 'a' and 'c' were significantly different from tunnels 'k' and 'l'; and an equation was derived to represent the relationship (eq 2). A regression that included the %VX recovered yielded a lower r^2 of 0.89. The least squares equation generated was then used to predict the evaporation rate for each sample (Table 4).

$$\begin{aligned}\text{Raw evaporation rate} = {} & -8.08 \times 10^{-3} + 1.41 \times 10^{-4} * T + 4.05 \times 10^{-4} * \text{Drop mass} \\ & + 5.52 \times 10^{-5} * \%\text{VX vapor recovered} \\ & + 1.30 \times 10^{-6} * (\text{drop mass} - 4.4) * (\text{air flow} - 207) \\ & + 7.33 \times 10^{-7} * (T - 42.6) * (\text{air flow} - 207) \\ & + 1.08 \times 10^{-3} * \text{tunnel[a]} - 9.83 \times 10^{-4} * \text{tunnel[c]} \end{aligned} \quad (2)$$

3.4 Combined Effects

The simultaneous effect of both degradation and evaporation was calculated. Degradation rates for VX on washed glass were calculated from the air-dried sand (ADS) values at 22, 30, 40, and 50 °C and the washed glass (WG) degradation rates at 22 °C for 97% or purer VX.[4] At 22 °C, the ratio $k_{WG}/k_{ADS} = 0.0059/0.0181 = 0.325$. The rate constants at 50 °C for ADS (0.0912 hr^{-1}) and the interpolated k at 35 °C (0.057 hr^{-1}) were multiplied by 0.325 to give an estimate for the degradation rate on washed glass. Thus, the percentage of VX that had evaporated, degraded, and remained was plotted as a function of time for 35 and 50 °C (Figure 13).

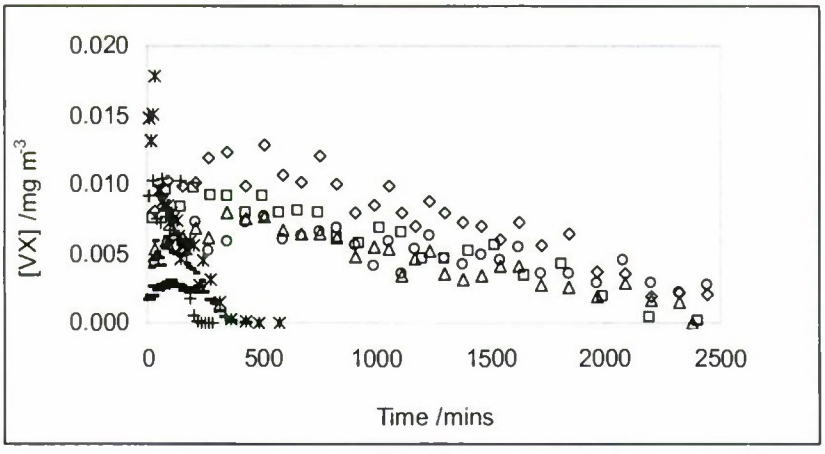


Figure 3. Vapor Concentrations for 1 μL Droplets of VX Evaporating from Glass at 35 °C, 18 SLPM (△,□,◇,○), and 50 °C, 405 SLPM (×,+,∗,–).

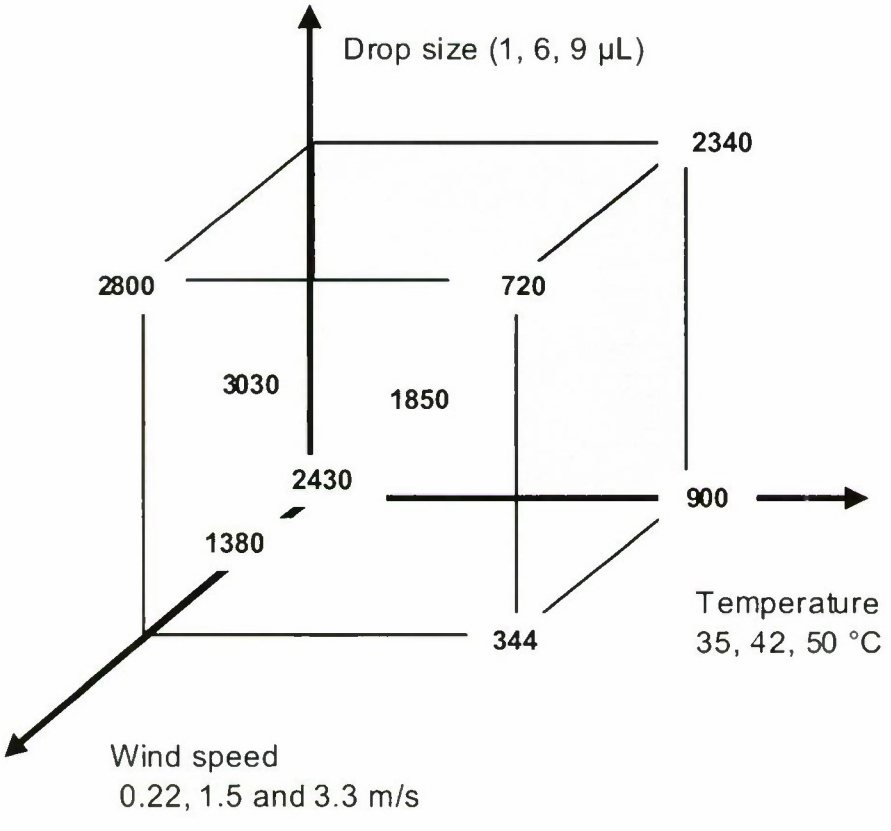


Figure 4. Average Time to Reach a Plateau in the Evaporation Rate of VX from Glass.

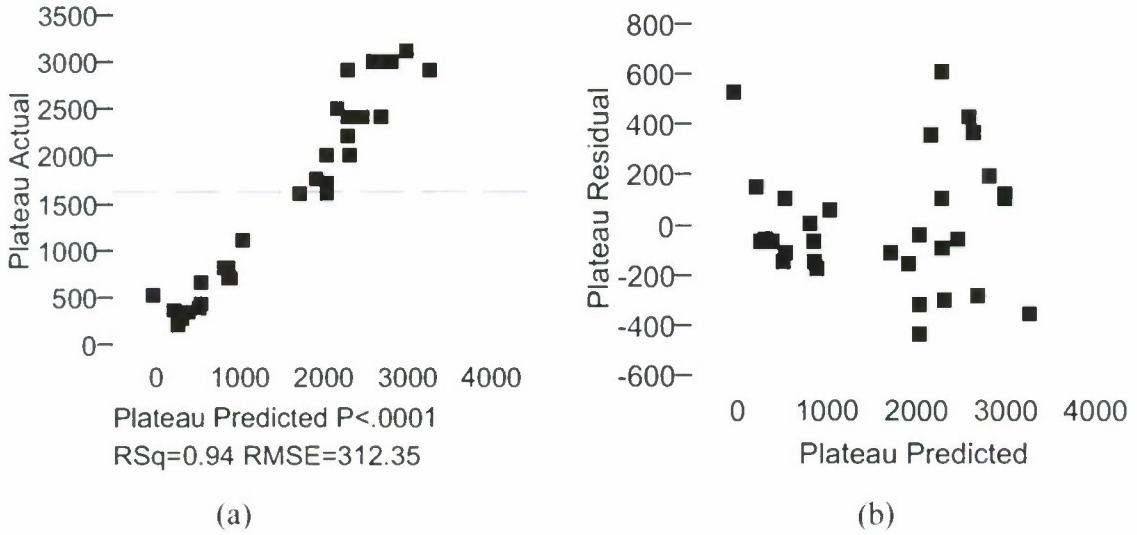


Figure 5. Actual vs. Predicted Plots for the Time Taken to Reach a Plateau for the Evaporation of VX from Glass. (a) Least Squares Regression Fit (b) Residuals.

Table 1. Parameter Estimates for Major Effects for the Time to Plateau during the Evaporation of VX from Glass.[c]

Term	Estimate	Std Error	Prob>|t|
Intereept	6315	452	<.0001
Temperature, T/°C	-107	11	<.0001
Drop mass /mg	145	31	0.0001
Air Flow rate/SLPM	-2.2	0.7	0.0056
%VX reeovered	-7.2	2.9	0.0229
tunnel[a]	-914	285	0.0044
tunnel[e]	324	198	0.118
tunnel[k]	215	141	0.144
(T-43.8)*(mg-4.3)	-6.4	4.4	0.156
(T-43.8)*(SLPM-223)	-0.02	0.10	0.833
(mg-4.3)*(SLPM-223)	-0.42	0.12	0.0025

[c] Values of Prob>|t| less than 0.05 are considered significant.

Table 2. Conditions and Experimental Evaporation Rates for the Evaporation of VX from Glass.

Code	Temp/ °C	Drop Mass/ mg	Air Flow/ SLPM	% VX recovered	Raw evaporation rate/ $\mu g\ min^{-1}$	Time to reach a Plateau/ min	Average %VX recovered	Standard Deviation %VX recovered	Average raw evaporation rate/$\mu g\ min^{-1}$	Standard Deviation raw evaporation rate/$\mu g\ min^{-1}$	Average plateau time/ min	VX purity/ %
3k-016	34.5	0.92	181.7	52.7	0.33	1750						n/a
3a-115	34.9	0.92	181.9	45.1	0.71	800						n/a
3c-157	35.2	0.92	181.3	86.1	0.60	1600	61	22	0.6	0.2	1383	n/a
3l-039	35.3	0.92	18.7	26.3	0.15	2400						90.7
3k-037	35.3	0.92	18.7	24.1	0.11	na						91.4
3k-029	35.5	0.92	18.8	21.8	0.12	2500						88.3
3l-030	35.5	0.92	18.8	1.4	0.01	2400						n/a
3l-036	35.8	0.92	18.7	37.1	0.19	na	22	13	0.12	0.07	2433	91.4
3k-023	49.6	0.92	405.6	113.9	4.30	500						n/a
3k-035	49.8	0.92	406.2	33	1.10	420						95.2
3l-033	50.1	0.92	405.4	96.3	3.20	360						95.2
3l-034	50.1	0.92	405.7	53.8	2.10	370						95.2
3k-025	50.2	0.92	405.6	48	2.10	320						n/a
3k-034	50.3	0.92	405.6	58.3	2.90	250						95.2
3k-027	50.5	0.92	405.6	62	3.10	190	66	28	2.7	1.0	344	90.4
3k-024	50.4	0.92	18.7	7	0.07	1100						n/a
3k-026	50.6	0.92	18.7	27	0.36	700	17	14	0.2	0.2	900	n/a
3k-022	34.5	5.51	181.7	43.3	1.03	3100						n/a
3a-116	34.6	5.51	181.9	13.3	0.75	na						n/a
3l-020	34.8	5.51	181.6	24.8	0.58	2900						n/a
3c-158	35.2	5.51	181.3	49.3	1.10	3100	33	17	0.9	0.2	3033	n/a
3k-028	41.4	5.51	181.7	113.8	7.20	na						n/a
3k-033	41.8	5.51	181.6	61.8	3.70	na						93.8
3l-032	41.8	5.51	181.6	42.9	2.40	na						93.8

Table 2. Conditions and Experimental Evaporation Rates for the Evaporation of VX from Glass (Continued).

Code	Temp/ °C	Drop Mass/ mg	Air Flow/ SLPM	% VX recovered	Raw evaporation/ rate/ µg min^{-1}	Time to reach a Plateau/ min	Average %VX recovered	Standard Deviation %VX recovered	Average raw evaporation rate/µg min^{-1}	Standard Deviation raw evaporation rate/µg min^{-1}	Average plateau time/ min	VX purity/ %
3k-038	42.0	5.51	181.6	58.6	2.60	1700						86.3
3l-037	42.2	5.51	181.5	74.9	3.20	2000						86.3
3k-031	42.2	5.51	181.7	40.3	3.70	na	65	27	4	2	1850	94.9
3l-027	34.7	8.27	405.4	75.3	3.90	2400						88.3
3l-031	34.7	8.27	405.4	53.5	1.40	na						94.8
3l-038	34.9	8.27	405	54.2	2.50	3000						80
3k-039	35.6	8.27	404.1	43	1.50	3000	57	14	2	1	2800	80
3l-029	35.5	8.27	18.7	17.3	0.39	na						89.2
3l-035	50.7	8.27	18.7	42	2.00	2900						93.3
3k-036	49.6	8.27	18.7	37.9	2.70	2000						93.3
3k-032	50.1	8.27	18.8	29.9	1.70	2200						94.8
3l-022	50.5	8.27	18.7	6.3	0.26	3000						n/a
3l-026	50.6	8.27	18.7	79	4.70	1600	35	25	2	2	2340	90.4
3l-021	50.1	8.27	405.4	34.8	5.00	800						n/a
3l-023	50.7	8.27	405.4	25.2	4.00	700						n/a
3l-025	50.6	8.27	405.5	70.1	8.90	650	43	24	6	3	717	90.4

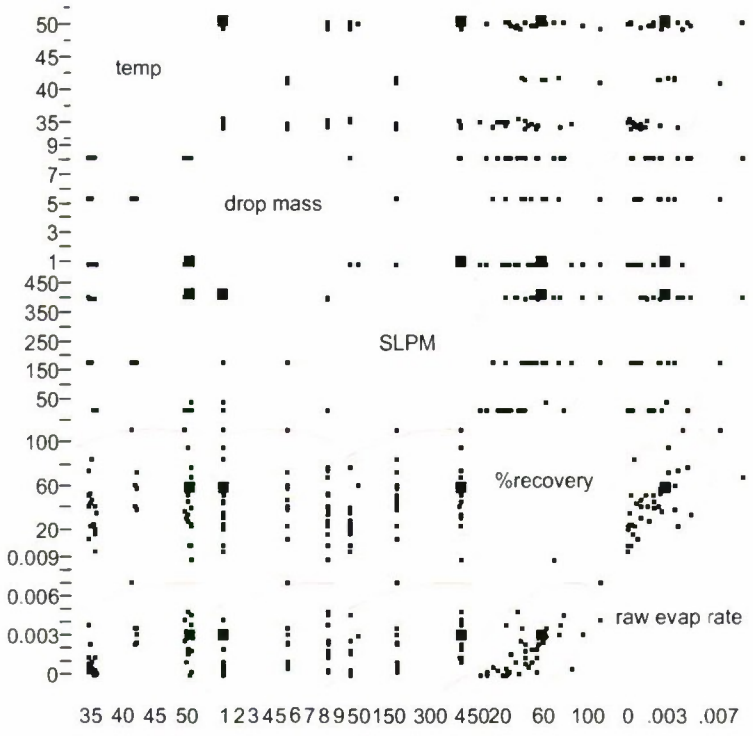


Figure 6. Scatterplot of Temperature, Drop Mass, Air Flow (SLPM), %Recovery, and Raw Evaporation Rate.

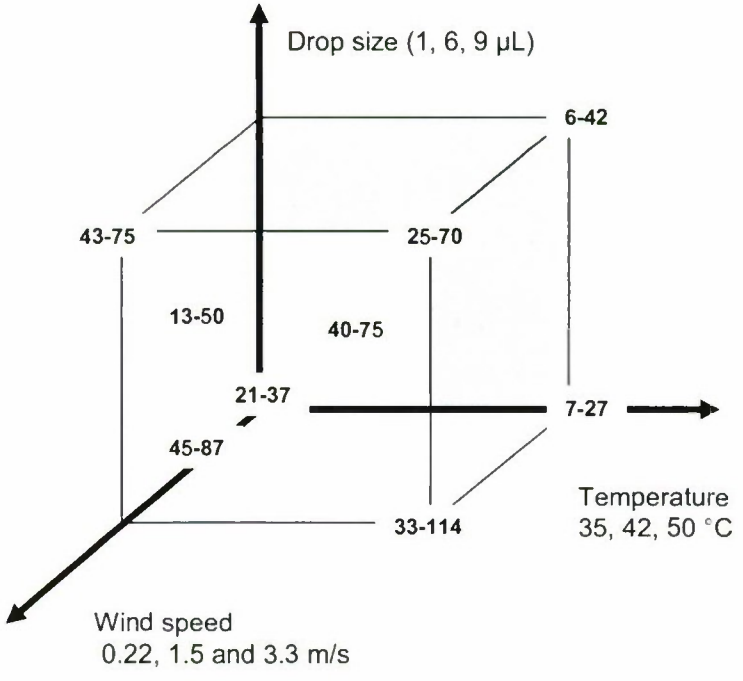


Figure 7. Cube Plot of %VX Recovered for Evaporation from Glass.

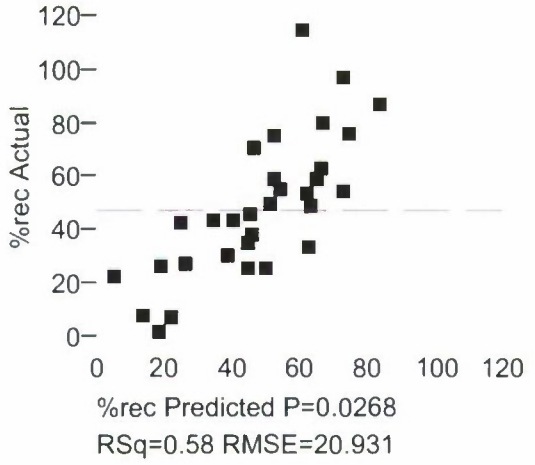


Figure 8. Least Squares Regression Analysis of %VX Recovered Data as a Function of Temperature, Air Flow, Drop Size, Tunnel Identity, and Time to Plateau.

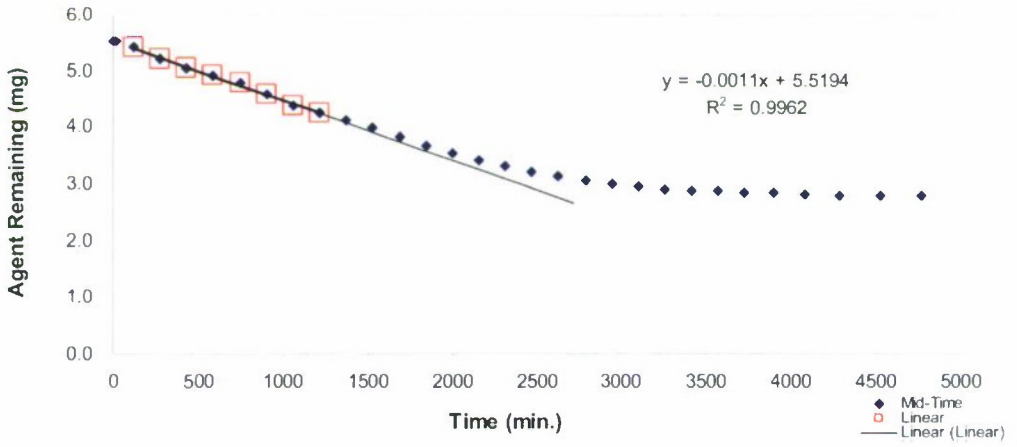


Figure 9. Calculation of the Evaporation Rate for a 6 µL Droplet of VX Evaporating from Glass at 35 °C and 181 SLPM. The squares show the data that were used to generate the regression line of slope 0.0011 mg/min.

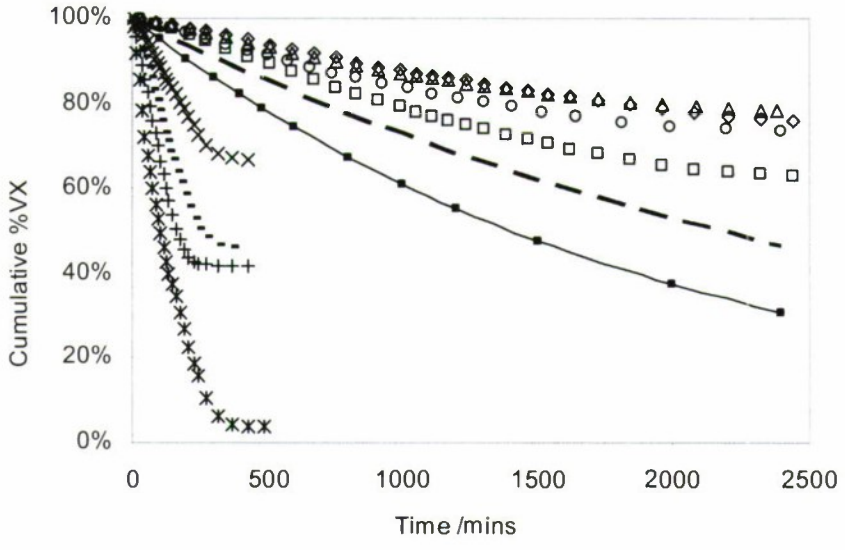


Figure 10. Cumulative VX Vapor Recovered for 1 µL Droplets of VX Evaporating from Glass at 35 °C, 18 SLPM (△,□,◇,○), and 50 °C, 405 SLPM (×,+,∗,–). The solid line represents the degradation rate of VX at 50 °C and the dashed line represents the degradation rate of VX at 35 °C.

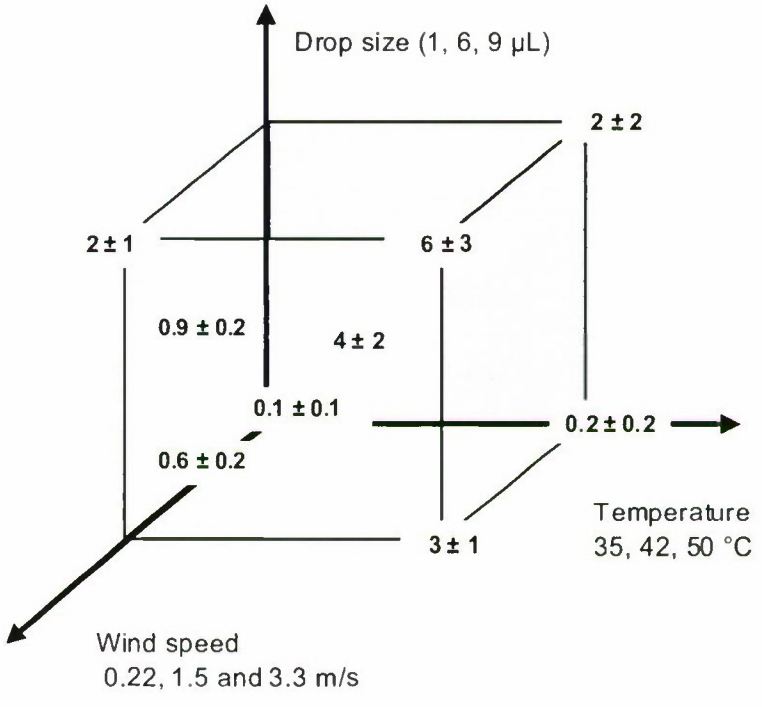


Figure 11. Cube Plot of the Raw Evaporation Rates (µg/min) for VX Evaporating from Glass.

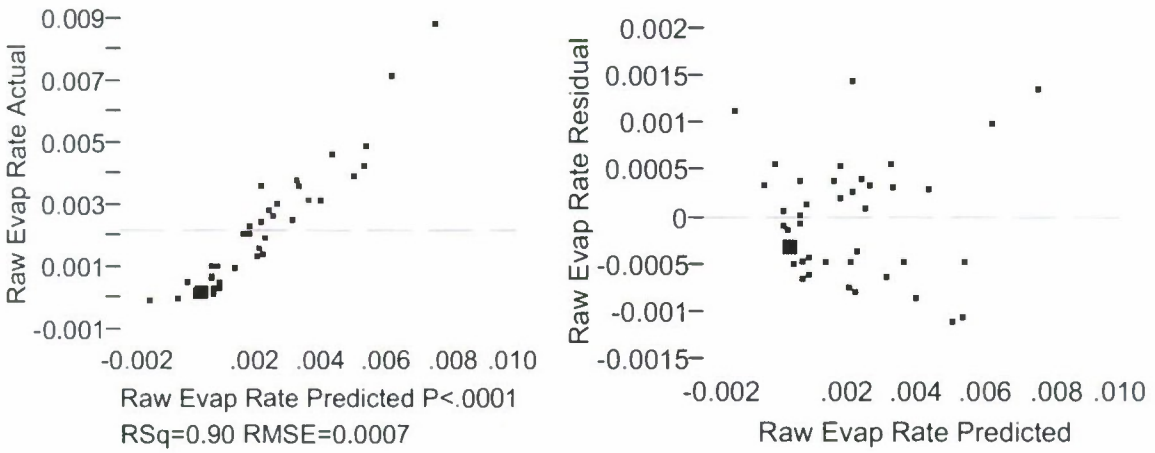
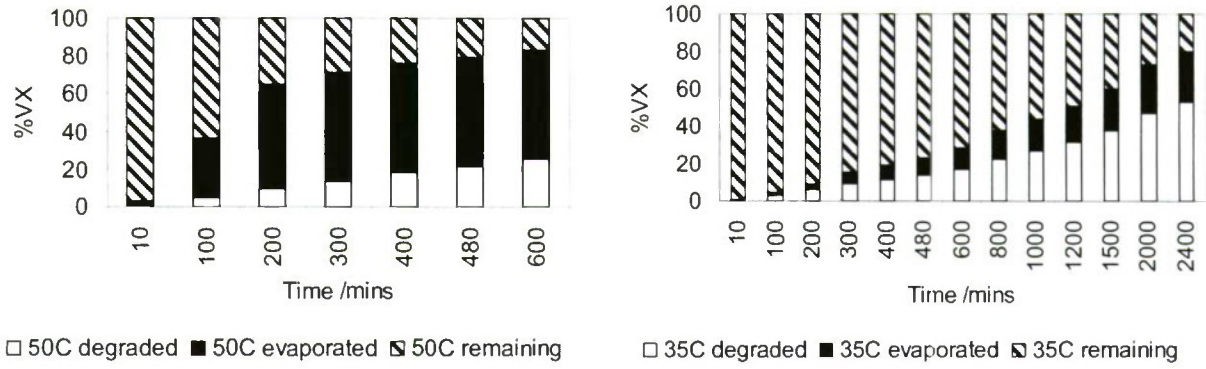


Figure 12. Actual vs. Predicted Plots for the Raw Evaporation Rates for VX on Glass. (a) Least squares regression fit (b) residuals.

Table 3. Parameter Estimates for the Major Effects Contributing to the Raw Evaporation Rate for the Evaporation of VX from Glass.[d]

Term	Estimate	Std Error	Prob>|t|
Intercept	-8.1×10^{-3}	9.4×10^{-4}	<.0001
Temperature, T /°C	1.4×10^{-4}	2.3×10^{-5}	<.0001
Drop mass /mg	4.0×10^{-4}	5.3×10^{-5}	<.0001
Air flow /SLPM	-1.0×10^{-6}	1.0×10^{-6}	0.3004
%VX vapor recovered	5.5×10^{-5}	6.0×10^{-6}	<.0001
(T-42.6)*(drop mass-4.4)	-8×10^{-7}	7.0×10^{-6}	0.9106
(drop mass-4.4)*(air flow-207)	1.3×10^{-6}	2.6×10^{-7}	<.0001
(T-42.6)*(air flow-207)	7.3×10^{-7}	1.5×10^{-7}	<.0001
tunnel[a]	1.1×10^{-3}	4.5×10^{-4}	0.0219
tunnel[e]	-9.8×10^{-4}	4.3×10^{-4}	0.0316
tunnel[k]	1.9×10^{-4}	2.6×10^{-4}	0.4716

[d] Values of Prob>|t| less than 0.05 are considered significant.



(a) (b)

Figure 13. Relative Contributions of Degradation and Evaporation for the Loss of VX from Glass. (a) 50 °C (b) 35 °C.

Table 4. Comparison of Predicted and Measured Raw Evaporation Rates for the Evaporation of VX from Glass.

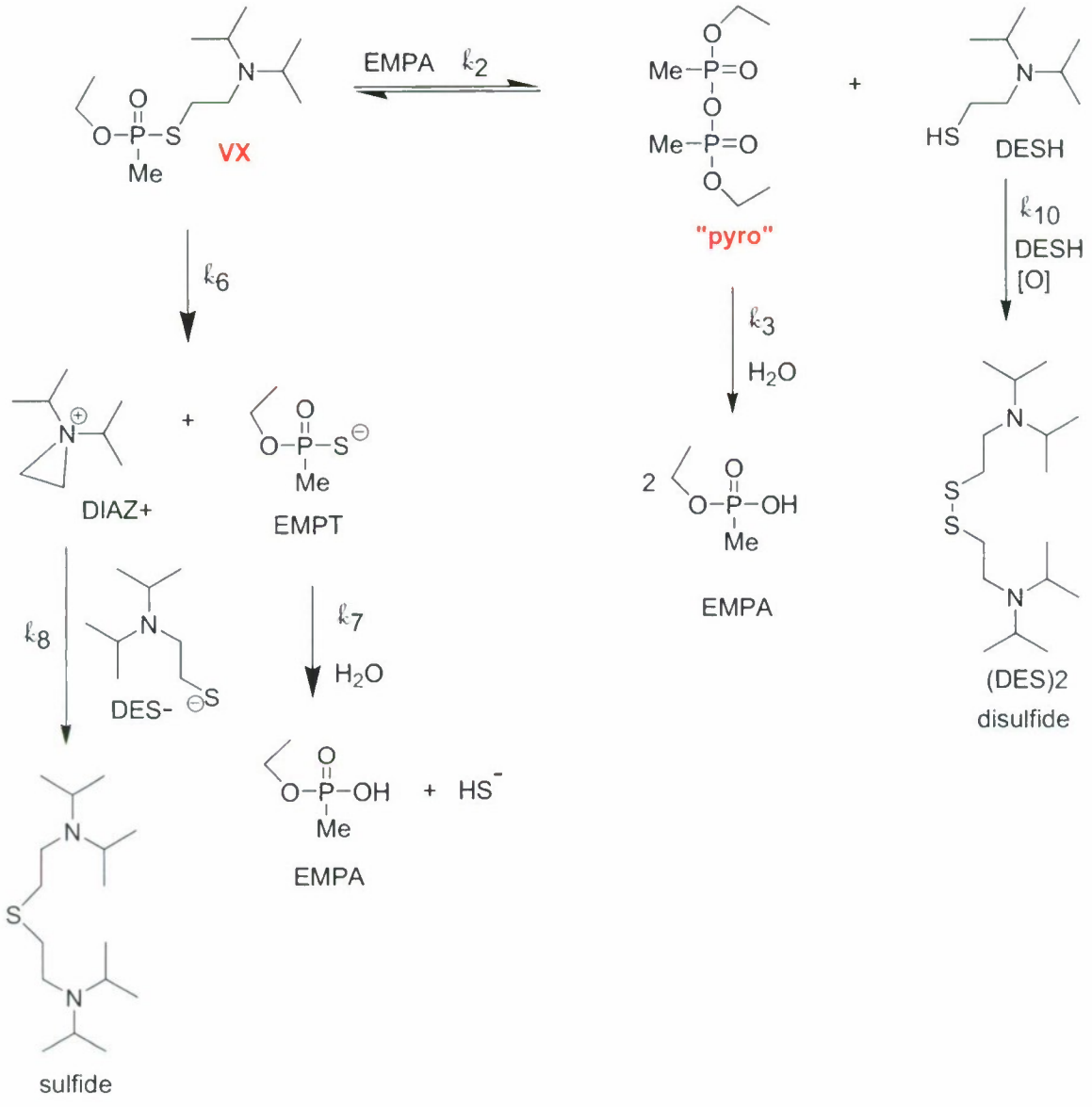
Code	Temperature/ °C	Drop mass/ mg	Air Flow/ SLPM	Raw Evaporation/ Rate $\mu g\ min^{-1}$	Predicted Raw Evaporation Rate/ $\mu g\ min^{-1}$
3k-016	34.5	0.92	181.7	0.33	0.23
3a-115	34.9	0.92	181.9	0.71	0.76
3c-157	35.2	0.92	181.3	0.60	1.0
3l-039	35.3	0.92	18.7	0.15	0.22
3k-037	35.3	0.92	18.7	0.11	0.57
3k-029	35.5	0.92	18.8	0.12	0.45
3l-030	35.5	0.92	18.8	0.01	-1.2
3l-036	35.8	0.92	18.7	0.19	0.8
3k-023	49.6	0.92	405.6	4.3	5.3
3k-035	49.8	0.92	406.2	1.1	0.94
3l-033	50.1	0.92	405.4	3.2	4.0
3l-034	50.1	0.92	405.7	2.1	1.7
3k-025	50.2	0.92	405.6	2.1	1.9
3k-034	50.3	0.92	405.6	2.9	2.5
3k-027	50.5	0.92	405.6	3.1	2.7
3k-024	50.4	0.92	18.7	0.07	-0.29
3k-026	50.6	0.92	18.7	0.36	0.81
3k-022	34.5	5.51	181.7	1.03	1.5
3a-116	34.6	5.51	181.9	0.75	0.70
3l-020	34.8	5.51	181.6	0.58	0.0
3c-158	35.2	5.51	181.3	1.1	0.70
3k-028	41.4	5.51	181.7	7.2	6.2
3k-033	41.8	5.51	181.6	3.7	3.4
3l-032	41.8	5.51	181.6	2.4	1.8
3k-038	42	5.51	181.6	2.6	3.2
3l-037	42.2	5.51	181.5	3.2	3.7
3k-031	42.2	5.51	181.7	3.7	2.2
3l-027	34.7	8.27	405.4	3.9	3.3
3l-031	34.7	8.27	405.4	1.4	2.1
3l-038	34.9	8.27	405	2.5	2.2
3k-039	35.6	8.27	404.1	1.5	2.3
3l-029	35.5	8.27	18.7	0.39	1.0
3l-035	50.7	8.27	18.7	2.0	2.3
3k-036	49.6	8.27	18.7	2.7	2.6
3k-032	50.1	8.27	18.8	1.7	2.1
3l-022	50.5	8.27	18.7	0.26	0.37
3l-026	50.6	8.27	18.7	4.7	4.4
3l-021	50.1	8.27	405.4	5.0	5.4
3l-023	50.7	8.27	405.4	4.0	5.1
3l-025	50.6	8.27	405.5	8.9	7.5

4. DISCUSSION

The precise reasons for the large, vexing variation in %VX recovered and raw evaporation rate remains unknown. The raw evaporation rate was derived from the cumulative %VX recovered. Thus, the loose correlation between %VX recovered and raw evaporation rate was not surprising. The least squares analysis used both %VX recovered and raw evaporation rate to generate the predictive empirical equation that had $r^2 = 0.90$.

Since the drops were not individually weighed, the exact mass for each drop was not known, which would also add variability to the data. In addition, small changes in the amount of adventitious water present in the VX would affect the VX degradation rate, which would in turn affect the %VX recovered. Independent studies[4] showed that the VX degraded with a half-life of 16 hr (960 min) at 30 °C, and 8 hr (480 min) at 40 and 50 °C. Thus, agent degradation was competing with agent evaporation in these experiments. Comparisons of the measured evaporation rates with the calculated degradation rates indicated that both processes occurred on a similar timescale. For the 50 °C samples, there was great variation in the cumulative %VX values (Figure 10), although evaporation for all samples had ceased at 400 min, indicating that all the VX had been exhausted. A mid-range sample was chosen for the comparison of the two processes. The calculated comparisons of evaporation and degradation at 50 °C in the bar graph indicated that VX would still be present at 600 min, but the vapor recovery in all cases indicated that the evaporation of the VX had ceased. This difference may indicate that the actual degradation rate was faster than the rate used in the calculations, possibly due to water in the air or EMPA in the VX. In addition, as the VX evaporated, the concentration of EMPA increased, thus increasing the degradation rate further in the autocatalytic cycle. As seen in Scheme 2, EMPA is both product and reactant for the degradation of VX. Thus, degradation rates in an open system may be faster than in a closed system at the same temperature. At 35 °C, the calculations indicated that VX would be present at 2400 min, as observed. The degradation rate was faster than the evaporation rate at 35 °C, whereas the evaporation rate was faster at 50 °C. The rate constants for degradation did not consider air flow or drop size effects, and thus only the temperature component is reflected in the bar graphs. In other words, with a different air flow or drop size, the evaporation/degradation balance will shift.

The EMPA formed is non-volatile; thus a mass-only method (such as balances or TGA) for following the evaporation of VX would be difficult, because the mass loss would be due to both VX and diisopropylaminoethyl thiol (DESH). As much as 3% EMPT product was detected in the NMR studies; the wind tunnel studies were not designed to detect the expected concomitant bis(2-diisopropylaminoethyl) sulfide product.



Scheme 2. Degradation Pathways for VX.[4]

5. CONCLUSIONS

During the first 1500 min, the VX vapors emanating from the glass substrate were above the Immediately Dangerous to Life and Health (IDLH) limit of 3×10^{-3} mg/m^3 (IDLH is the Occupational Safety and Health Admininstration [OSHA] limit and the short-term exposure limit [STEL] of 1×10^{-5} mg/m^3).[10] Both degradation and evaporation were equally important contributors to the concentration decrease of VX vapors in these experiments. The exact point at which no further agent evaporated depended on the temperature, drop size, humidity of the air, and initial purity of the VX.

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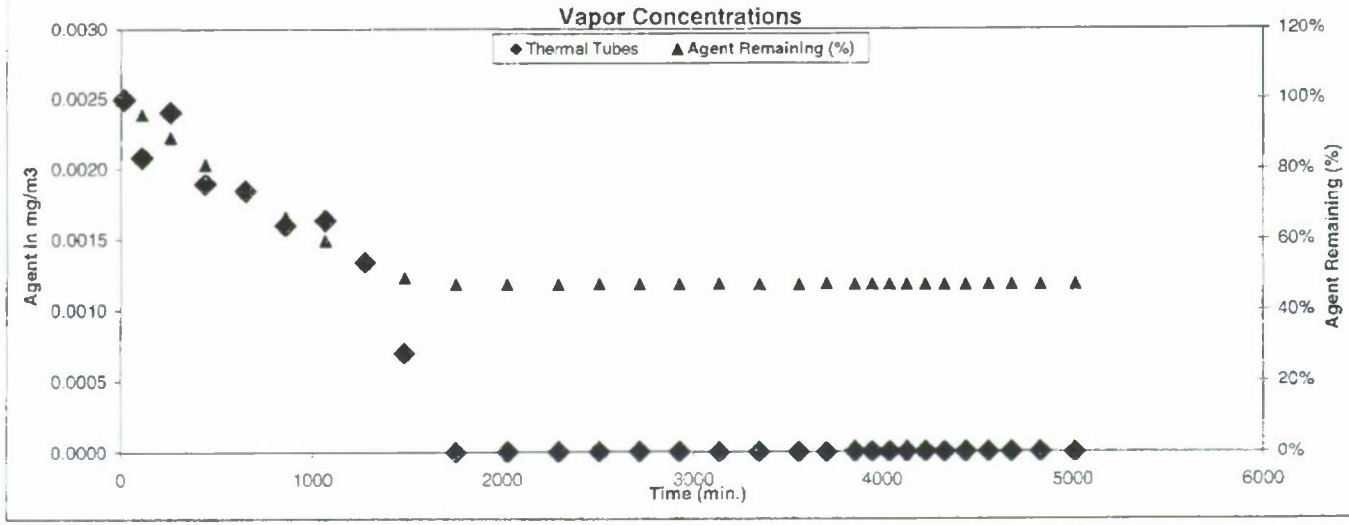
APPENDIX: WIND TUNNEL DATA

1 Copy 20060803_3k_016(- - 0_a_1)VX_G.xls

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	08/03/06	16
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	1 µL	
Mass of agent disseminated:	1.01 mg	
Corrected mass on 100% agent purity:	0.92 mg	
Average substrate temperature:	34.53 °C	
Average air flow rate:	181.68 SLPM	
Average air temperature above drop:	35.03 °C	
CCVs within criteria:	No	
Mass % recovery by extraction:	n/a %	
Total agent % mass recovery:	52.7 %	
Mass % recovery in vapor:	52.7 %	
Tube #s consistant:	Yes	
Comments:	First VX run ever done in ECBC 5cm tunnel. 1 of 3 ccvs outside current criteria.	

Evaporation Rate: 0.00033 mg/min



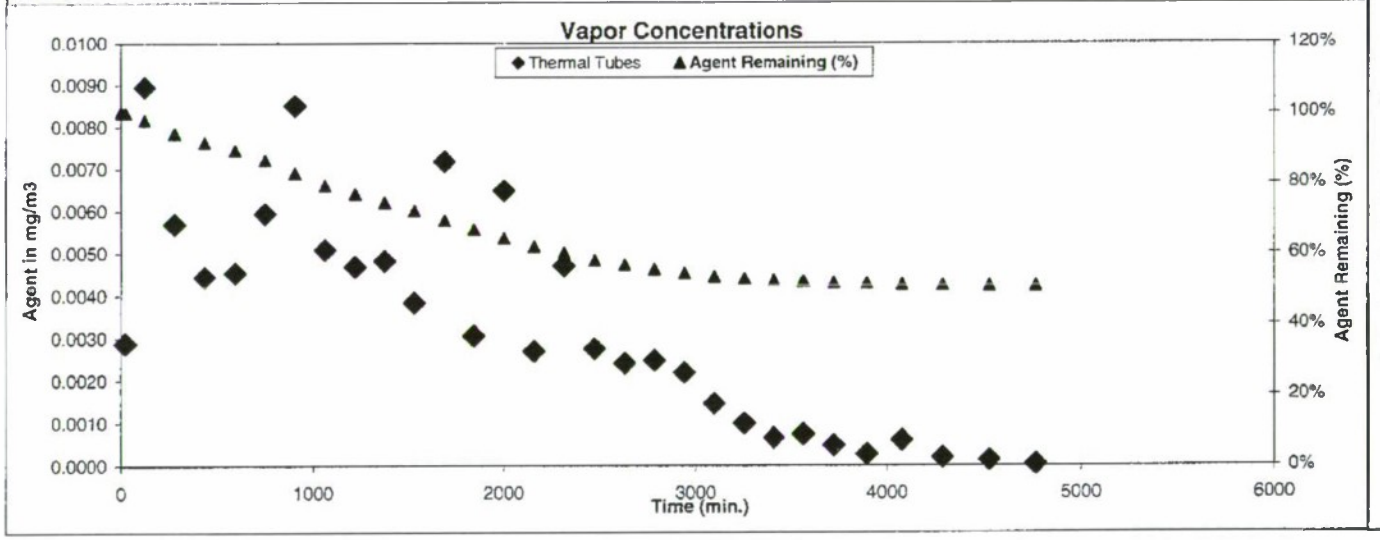
Time (min)	Conc. mg/m^3	Agent rem. (%)
15.83	2.50E-03	99.61%
105.88	2.08E-03	95.54%
255.92	2.41E-03	88.89%
435.97	1.89E-03	81.24%
646.02	1.84E-03	73.48%
856.07	1.60E-03	66.32%
1066.12	1.64E-03	59.61%
1276.17	1.34E-03	53.43%
1486.22	6.98E-04	49.20%
1756.27	0.00E+00	47.33%
2026.32	0.00E+00	47.33%
2296.37	0.00E+00	47.33%
2506.42	0.00E+00	47.33%
2716.47	0.00E+00	47.33%
2926.52	0.00E+00	47.33%
3136.57	0.00E+00	47.33%
3346.62	0.00E+00	47.33%
3556.67	0.00E+00	47.33%
3706.72	0.00E+00	47.33%
3856.77	0.00E+00	47.33%
3946.82	0.00E+00	47.33%
4036.87	0.00E+00	47.33%
4131.92	0.00E+00	47.33%
4231.97	0.00E+00	47.33%
4332.02	0.00E+00	47.33%
4442.07	0.00E+00	47.33%
4562.12	0.00E+00	47.33%
4682.17	0.00E+00	47.33%
4832.22	0.00E+00	47.33%
5012.27	0.00E+00	47.33%

3 20060808_3a_115(- - 0_61_1)VX_G.xls

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3c	
Instruments:	VTS#01/GCMSD	
Date/Experiment #:	08/10/06	158
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	6	µL
Mass of agent disseminated:	6.06	mg
Corrected mass on 100% agent purity:	5.51	mg
Average substrate temperature:	35.17	°C
Average air flow rate:	181.31	SLPM
Average air temperature above drop:	35.54	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	49.3	%
Mass % recovery in vapor:	49.3	%
Tube #s consistant:	Yes	
Comments:	n/a	

Raw evaporation rate: 0.00071 mg/min

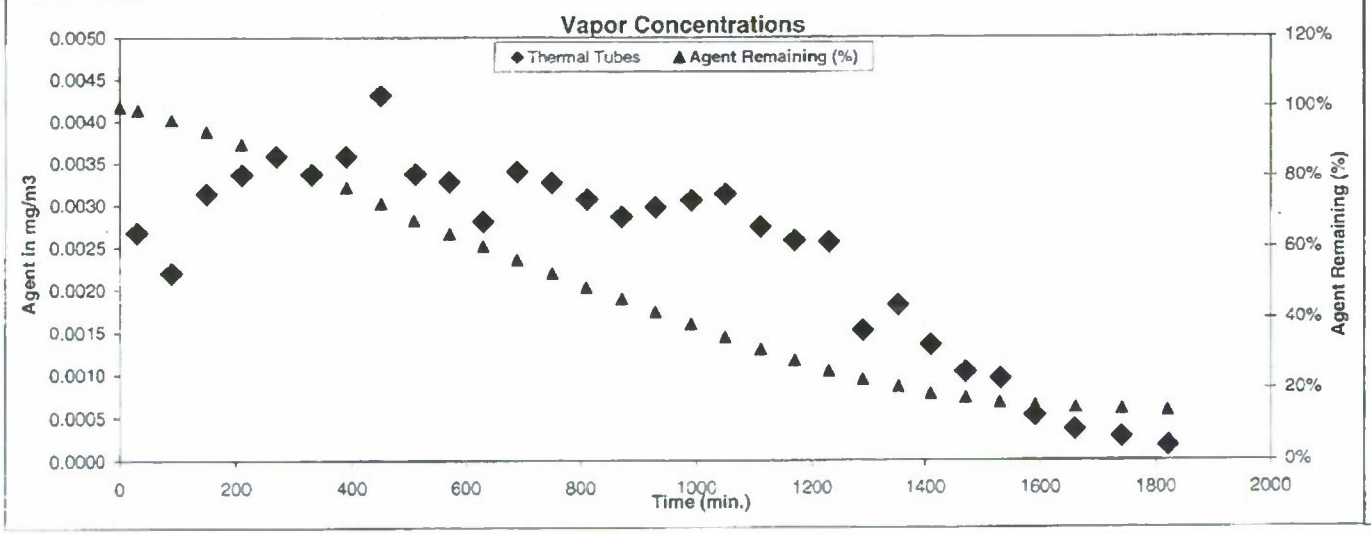


Time (min)	Conc. mg/m^3	Agent rem. (%)
21.28	2.88E-03	99.90%
121.33	8.95E-03	97.95%
278.05	5.69E-03	94.18%
434.77	4.44E-03	91.57%
591.47	4.53E-03	89.26%
748.18	5.93E-03	86.56%
904.90	8.49E-03	82.85%
1061.62	5.06E-03	79.35%
1218.33	4.69E-03	76.83%
1375.05	4.82E-03	74.38%
1531.77	3.83E-03	72.15%
1688.48	7.17E-03	69.32%
1845.20	3.05E-03	66.68%
2001.92	6.48E-03	64.23%
2158.63	2.70E-03	61.86%
2315.35	4.70E-03	59.96%
2472.07	2.75E-03	58.04%
2628.78	2.41E-03	56.71%
2785.50	2.47E-03	55.45%
2942.22	2.19E-03	54.25%
3098.93	1.45E-03	53.31%
3255.65	9.88E-04	52.68%
3412.37	6.49E-04	52.26%
3569.08	7.34E-04	51.91%
3725.80	4.68E-04	51.60%
3895.85	2.61E-04	51.39%
4075.90	5.85E-04	51.14%
4285.95	1.86E-04	50.87%
4526.00	1.26E-04	50.75%
4766.05	3.97E-05	50.69%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3c	
Instruments:	VTS#01/GCMSD	
Date/Experiment #:	08/08/06	157
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	1	µL
Mass of agent disseminated:	1.01	mg
Corrected mass on 100% agent purity:	0.92	mg
Average substrate temperature:	35.23	°C
Average air flow rate:	181.31	SLPM
Average air temperature above drop:	35.52	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	86.1	%
Mass % recovery in vapor:	86.1	%
Tube #s consistant:	Yes	
Comments:	First VX run performed in tunnel 3c	

Raw evaporation rate: 0.00060 mg/min

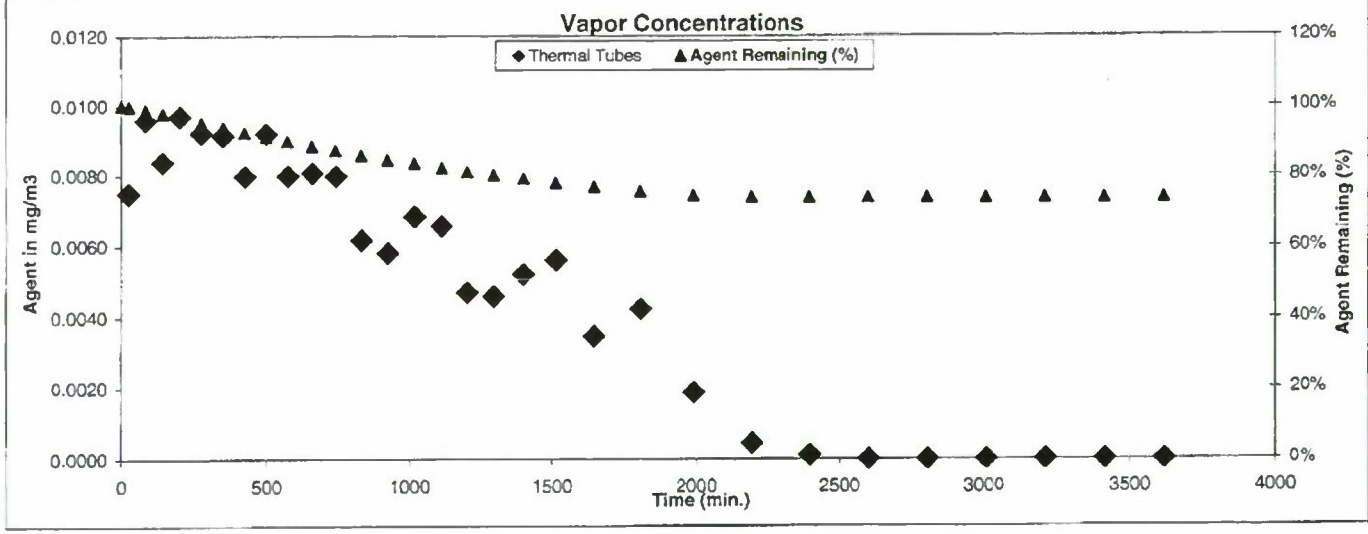


Time (min)	Conc. mg/m^3	Agent rem. (%)
30.15	2.67E-03	99.21%
90.20	2.20E-03	96.32%
150.25	3.13E-03	93.17%
210.30	3.36E-03	89.32%
270.35	3.57E-03	85.22%
330.40	3.36E-03	81.11%
390.45	3.57E-03	77.00%
450.50	4.30E-03	72.33%
510.55	3.37E-03	67.79%
570.60	3.28E-03	63.85%
630.65	2.80E-03	60.25%
690.70	3.40E-03	56.58%
750.73	3.27E-03	52.63%
810.78	3.07E-03	48.88%
870.83	2.85E-03	45.38%
930.90	2.97E-03	41.93%
990.95	3.05E-03	38.36%
1051.00	3.13E-03	34.70%
1111.05	2.75E-03	31.22%
1171.10	2.58E-03	28.07%
1231.13	2.56E-03	25.03%
1291.18	1.52E-03	22.62%
1351.23	1.82E-03	20.64%
1411.28	1.35E-03	18.77%
1471.33	1.03E-03	17.36%
1531.38	9.50E-04	16.19%
1591.43	5.23E-04	15.32%
1661.48	3.52E-04	14.71%
1741.53	2.70E-04	14.22%
1821.58	1.69E-04	13.87%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3L	
Instruments:	VTS#10/GCMSD	
Date/Experiment #:	10/23/06	39
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	1 µL	
Mass of agent disseminated:	1.01 mg	
Corrected mass on 100% agent purity:	0.92 mg	
Average substrate temperature:	35.32 °C	
Average air flow rate:	18.74 SLPM	
Average air temperature above drop:	35.38 °C	
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a %	
Total agent % mass recovery:	26.3 %	
Mass % recovery in vapor:	26.3 %	
Tube #s consistant:	Yes	
Comments:	n/a	

Raw evaporation rate: 0.00015 mg/min

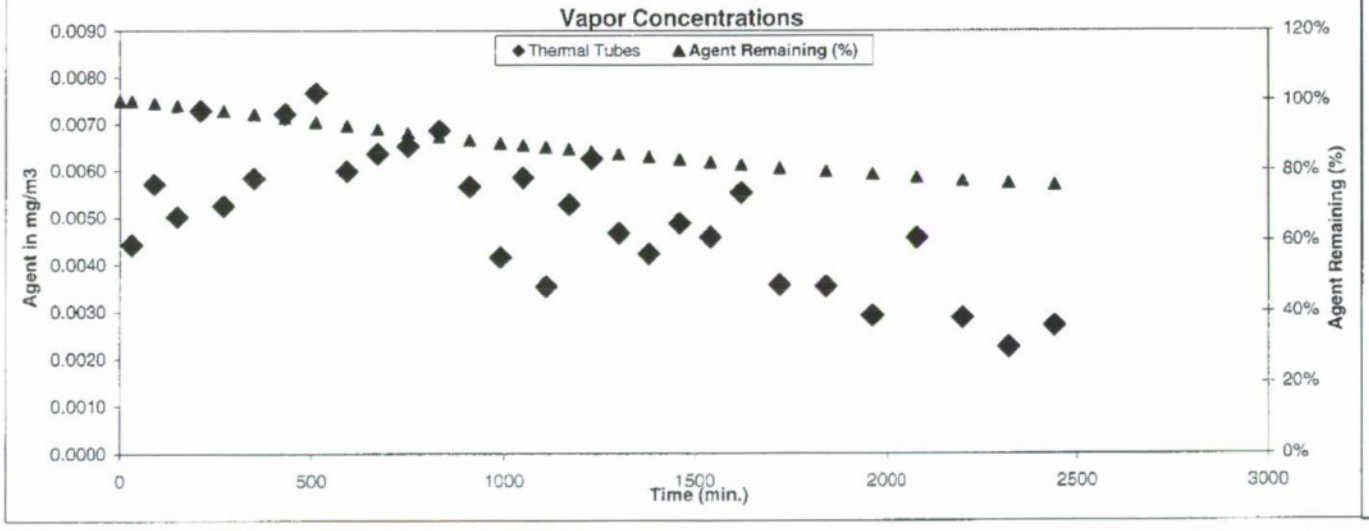


Time (min)	Conc. mg/m^3	Agent rem. (%)
25.90	7.49E-03	99.80%
84.28	9.58E-03	98.79%
142.67	8.38E-03	97.72%
201.03	9.69E-03	96.64%
276.08	9.22E-03	95.19%
351.13	9.14E-03	93.79%
426.18	8.00E-03	92.48%
501.23	9.21E-03	91.16%
576.28	8.01E-03	89.84%
659.67	8.07E-03	88.48%
743.05	7.99E-03	87.11%
831.43	6.18E-03	85.83%
924.82	5.81E-03	84.69%
1018.20	6.84E-03	83.49%
1111.58	6.58E-03	82.21%
1204.97	4.70E-03	81.14%
1298.35	4.60E-03	80.25%
1401.73	5.21E-03	79.22%
1515.12	5.62E-03	77.96%
1645.17	3.48E-03	76.76%
1808.55	4.24E-03	75.47%
1991.93	1.88E-03	74.33%
2195.32	4.41E-04	73.85%
2398.70	1.10E-04	73.73%
2602.08	0.00E+00	73.71%
2805.47	0.00E+00	73.71%
3008.85	0.00E+00	73.71%
3212.23	0.00E+00	73.71%
3415.62	0.00E+00	73.71%
3619.00	0.00E+00	73.71%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	10/10/06	37
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	1	µL
Mass of agent disseminated:	1.01	mg
Corrected mass on 100% agent purity:	0.92	mg
Average substrate temperature:	35.29	°C
Average air flow rate:	18.71	SLPM
Average air temperature above drop:	35.19	°C
CCVs within criteria:	No	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	24.1	%
Mass % recovery in vapor:	24.1	%
Tube #s consistant:	Yes	
Comments:	3 of 3 ccvs outside current criteria	

Raw evaporation rate: 0.00011 mg/min

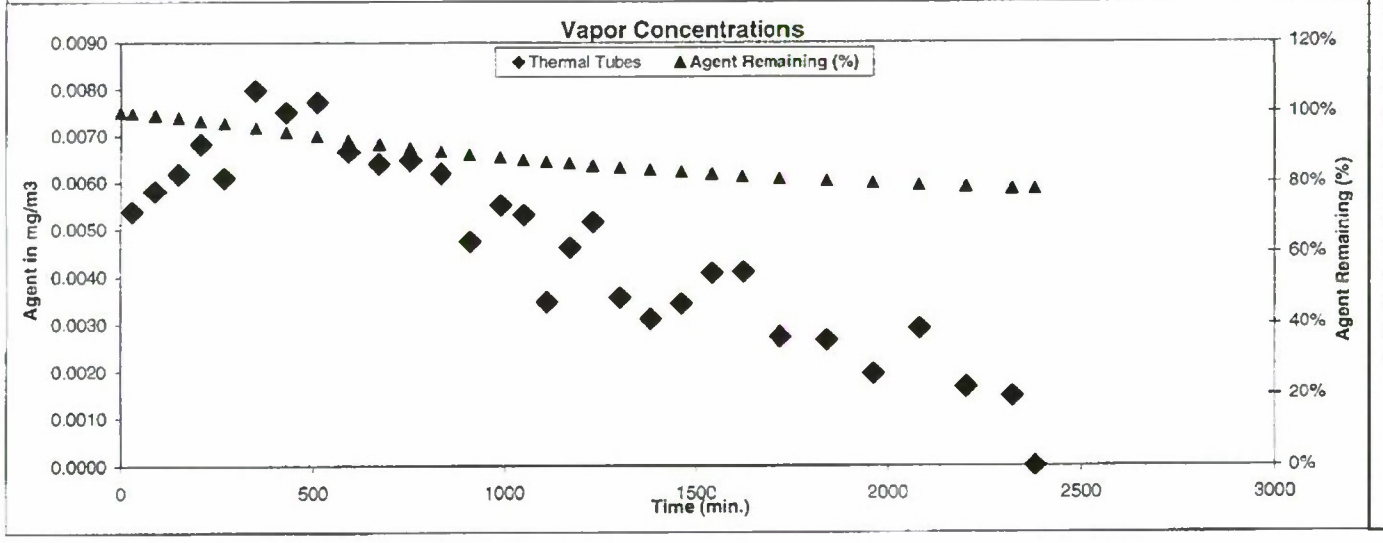


Time (min)	Conc. mg/m³	Agent rem. (%)
30.67	4.43E-03	99.86%
90.72	5.71E-03	99.24%
150.77	5.01E-03	98.59%
210.82	7.29E-03	97.84%
270.87	5.25E-03	97.07%
350.92	5.83E-03	96.17%
430.97	7.22E-03	95.10%
511.02	7.66E-03	93.89%
591.07	5.98E-03	92.78%
671.12	6.36E-03	91.78%
751.17	6.51E-03	90.73%
831.22	6.86E-03	89.64%
911.25	5.65E-03	88.62%
991.30	4.15E-03	87.82%
1051.35	5.85E-03	87.21%
1111.42	3.53E-03	86.64%
1171.47	5.28E-03	86.10%
1231.52	6.25E-03	85.39%
1301.57	4.66E-03	84.62%
1381.62	4.23E-03	83.89%
1461.67	4.88E-03	83.15%
1541.72	4.57E-03	82.38%
1621.75	5.53E-03	81.56%
1721.80	3.56E-03	80.63%
1841.85	3.53E-03	79.77%
1961.90	2.91E-03	78.98%
2081.95	4.56E-03	78.07%
2202.00	2.86E-03	77.16%
2322.05	2.25E-03	76.53%
2442.10	2.70E-03	75.93%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	09/11/06	29
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	1	µL
Mass of agent disseminated:	1.01	mg
Corrected mass on 100% agent purity:	0.92	mg
Average substrate temperature:	35.45	°C
Average air flow rate:	18.84	SLPM
Average air temperature above drop:	34.51	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	21.8	%
Mass % recovery in vapor:	21.8	%
Tube #s consistant:	Yes	
Comments:	n/a	

Raw evaporation rate: 0.00012 mg/min

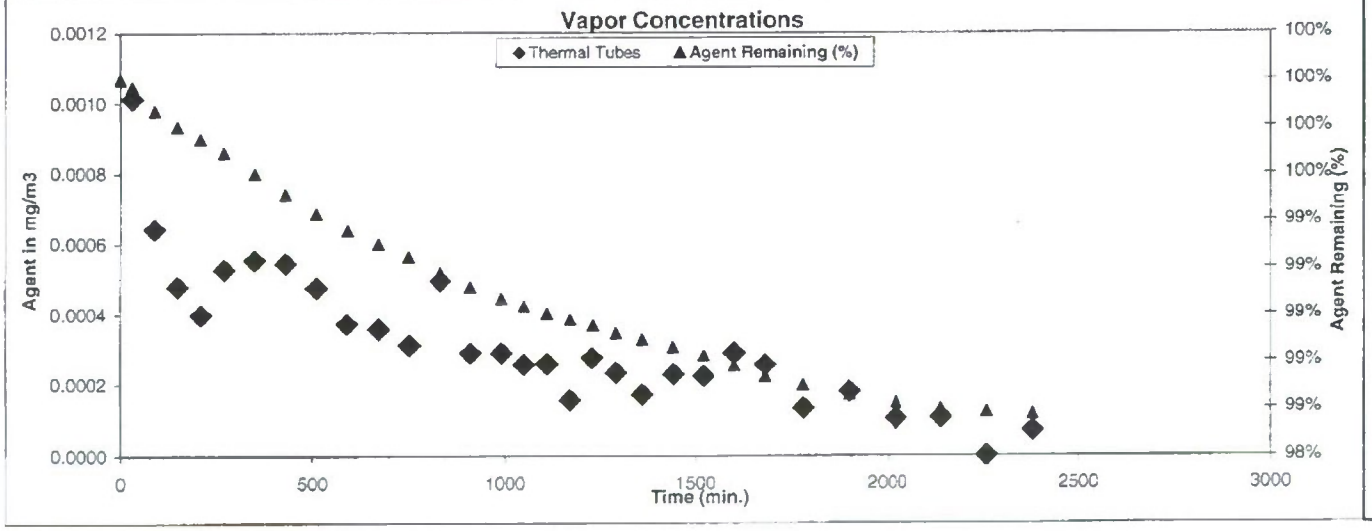


Time (min)	Conc. mg/m³	Agent rem. (%)
30.85	5.39E-03	99.83%
90.92	5.81E-03	99.14%
150.95	6.18E-03	98.40%
211.00	6.82E-03	97.60%
271.05	6.11E-03	96.80%
351.10	7.97E-03	95.65%
431.15	7.51E-03	94.38%
511.20	7.71E-03	93.13%
591.25	6.65E-03	91.95%
671.30	6.41E-03	90.88%
751.35	6.47E-03	89.82%
831.40	6.19E-03	88.78%
911.45	4.74E-03	87.89%
991.50	5.51E-03	87.05%
1051.55	5.31E-03	86.38%
1111.60	3.46E-03	85.84%
1171.65	4.60E-03	85.34%
1231.70	5.15E-03	84.74%
1301.75	3.55E-03	84.12%
1381.80	3.10E-03	83.57%
1461.85	3.42E-03	83.04%
1541.90	4.08E-03	82.42%
1621.95	4.10E-03	81.75%
1722.00	2.72E-03	81.05%
1842.05	2.66E-03	80.39%
1962.10	1.93E-03	79.82%
2082.15	2.89E-03	79.23%
2202.20	1.67E-03	78.67%
2322.25	1.45E-03	78.28%
2382.30	0.00E+00	78.20%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3L	
Instruments:	VTS#03/GCMSD	
Date/Experiment #:	09/26/06	30
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	1	µL
Mass of agent disseminated:	1.01	mg
Corrected mass on 100% agent purity:	0.92	mg
Average substrate temperature:	35.48	°C
Average air flow rate:	18.76	SLPM
Average air temperature above drop:	34.88	°C
CCVs within criteria:	No	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	1.4	%
Mass % recovery in vapor:	1.4	%
Tube #s consistant:	Yes	
Comments:	n/a	

Raw evaporation rate: 9.0E-6 mg/min

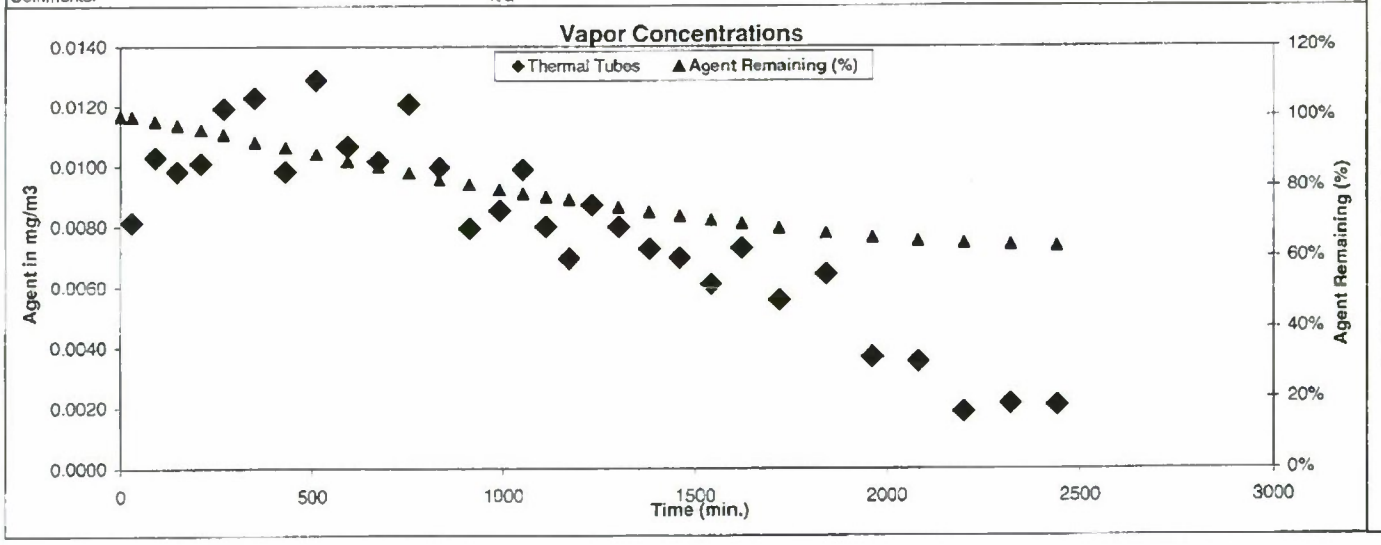


Time (min)	Conc. mg/m³	Agent rem. (%)
30.57	1.01E-03	99.97%
90.62	6.42E-04	99.87%
150.67	4.79E-04	99.80%
210.72	3.98E-04	99.74%
270.77	5.27E-04	99.69%
350.82	5.53E-04	99.60%
430.87	5.44E-04	99.51%
510.92	4.75E-04	99.43%
590.97	3.72E-04	99.36%
671.02	3.58E-04	99.30%
751.07	3.12E-04	99.24%
831.12	4.95E-04	99.18%
911.17	2.86E-04	99.11%
991.22	2.89E-04	99.07%
1051.27	2.57E-04	99.03%
1111.33	2.58E-04	99.00%
1171.38	1.55E-04	98.98%
1231.43	2.74E-04	98.95%
1291.48	2.32E-04	98.92%
1361.52	1.70E-04	98.89%
1441.57	2.28E-04	98.86%
1521.62	2.23E-04	98.82%
1601.67	2.89E-04	98.78%
1681.72	2.56E-04	98.73%
1781.77	1.33E-04	98.69%
1901.82	1.80E-04	98.66%
2021.87	1.04E-04	98.62%
2141.92	1.07E-04	98.60%
2261.97	0.00E+00	98.58%
2382.02	7.05E-05	98.57%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3L	
Instruments:	VTS#10/GCMSD	
Date/Experiment #:	10/10/06	36
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	1 µL	
Mass of agent disseminated:	1.01 mg	
Corrected mass on 100% agent purity:	0.92 mg	
Average substrate temperature:	35.84 °C	
Average air flow rate:	18.66 SLPM	
Average air temperature above drop:	35.39 °C	
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a %	
Total agent % mass recovery:	37.1 %	
Mass % recovery in vapor:	37.1 %	
Tube #s consistant:	Yes	
Comments:	n/a	

Raw evaporation rate: 0.00019 mg/min



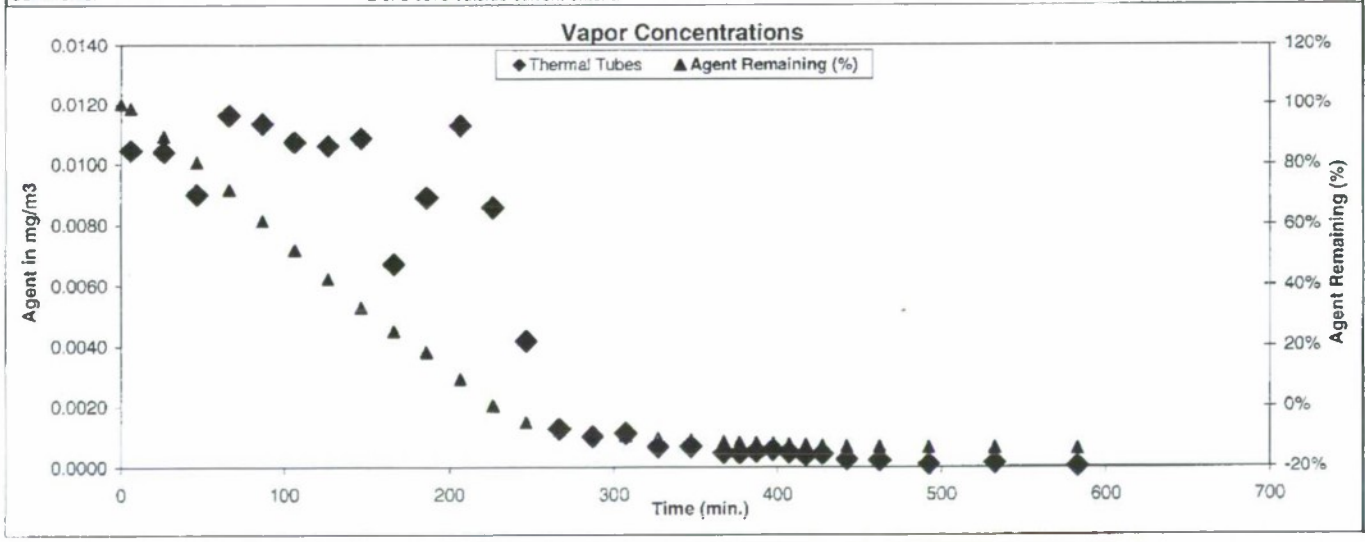
Time (min)	Conc. mg/m³	Agent rem. (%)
30.77	8.13E-03	99.75%
90.82	1.03E-02	98.62%
150.87	9.82E-03	97.40%
210.90	1.01E-02	96.18%
270.95	1.19E-02	94.84%
351.00	1.23E-02	92.87%
431.05	9.82E-03	91.08%
511.10	1.29E-02	89.23%
591.15	1.07E-02	87.32%
671.20	1.02E-02	85.62%
751.25	1.21E-02	83.81%
831.30	9.96E-03	82.02%
911.35	7.94E-03	80.57%
991.40	8.52E-03	79.23%
1051.45	9.87E-03	78.11%
1111.52	7.99E-03	77.02%
1171.57	6.94E-03	76.11%
1231.62	8.70E-03	75.16%
1301.67	7.99E-03	73.97%
1381.70	7.24E-03	72.73%
1461.75	6.93E-03	71.58%
1541.80	6.09E-03	70.52%
1621.85	7.29E-03	69.44%
1721.90	5.56E-03	68.13%
1841.95	6.43E-03	66.67%
1962.00	3.69E-03	65.44%
2082.05	3.52E-03	64.56%
2202.10	1.86E-03	63.90%
2322.15	2.13E-03	63.42%
2442.20	2.08E-03	62.90%

3 Copy of 20060821_3k_023(+ - +_a_1)VX_G.xls

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	08/21/06	23
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	1	µL
Mass of agent disseminated:	1.01	mg
Corrected mass on 100% agent purity:	0.92	mg
Average substrate temperature:	49.60	°C
Average air flow rate:	405.59	SLPM
Average air temperature above drop:	49.84	°C
CCVs within criteria:	No	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	113.9	%
Mass % recovery in vapor:	113.9	%
Tube #s consistant:	Yes	
Comments:	2 of 3 ccvs outside current criteria	

Raw evaporation rate: 0.0043 mg/min

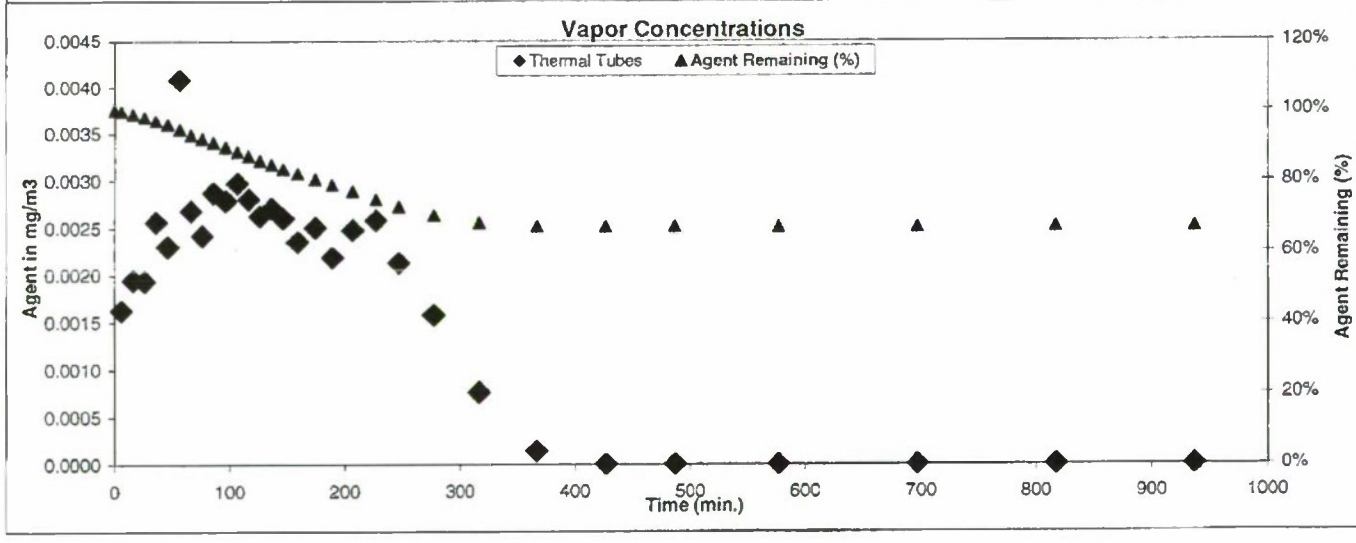


Time (min)	Conc. mg/m³	Agent rem. (%)
6.10	1.05E-02	98.59%
26.15	1.04E-02	89.35%
46.20	9.01E-03	80.76%
66.25	1.16E-02	71.62%
86.28	1.14E-02	61.46%
106.33	1.07E-02	51.68%
126.38	1.06E-02	42.23%
146.43	1.09E-02	32.72%
166.48	6.71E-03	24.95%
186.53	8.90E-03	18.04%
206.58	1.13E-02	9.11%
226.63	8.58E-03	0.32%
246.68	4.16E-03	-5.32%
266.73	1.26E-03	-7.72%
286.78	1.01E-03	-8.72%
306.83	1.11E-03	-9.66%
326.88	6.66E-04	-10.45%
346.93	6.75E-04	-11.04%
366.98	4.72E-04	-11.55%
377.03	4.70E-04	-11.76%
387.08	5.21E-04	-11.97%
397.13	5.70E-04	-12.22%
407.18	4.82E-04	-12.45%
417.23	3.88E-04	-12.64%
427.28	4.36E-04	-12.83%
442.33	2.54E-04	-13.06%
462.38	2.21E-04	-13.27%
492.43	9.29E-05	-13.47%
532.48	1.35E-04	-13.67%
582.53	3.25E-05	-13.86%

Data Evaluation Grade: **Modeling Grade** 11 Copy of 20061005_3k_035(+ - +_a_5)VX_G.xls

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	10/05/06	35
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	1	µL
Mass of agent disseminated:	1.01	mg
Corrected mass on 100% agent purity:	0.92	mg
Average substrate temperature:	49.76	°C
Average air flow rate:	406.23	SLPM
Average air temperature above drop:	50.00	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	33.0	%
Mass % recovery in vapor:	33.0	%
Tube #s consistant:	Yes	
Comments:	The absolute value of the standard deviation of flow is larger than what is considered reasonable.Leaking tube on cycle 12 - blue highlighted value mathematically determined	

Raw evaporation rate: 0.0011 mg/min

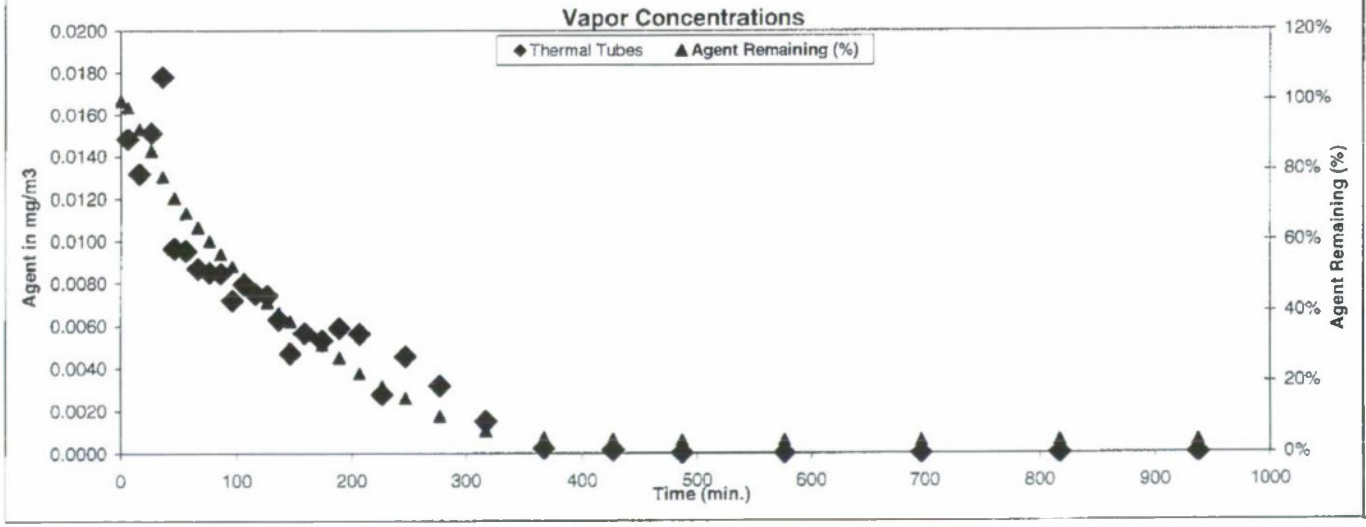


Time (min)	Conc. mg/m³	Agent rem. (%)
5.90	1.63E-03	99.79%
15.95	1.95E-03	98.99%
26.00	1.94E-03	98.13%
36.05	2.56E-03	97.13%
46.10	2.31E-03	96.05%
56.15	4.08E-03	94.63%
66.20	2.68E-03	93.13%
76.25	2.42E-03	91.99%
86.30	2.87E-03	90.82%
96.35	2.79E-03	89.56%
106.40	2.98E-03	88.28%
116.45	2.81E-03	86.99%
126.50	2.63E-03	85.79%
136.55	2.71E-03	84.60%
146.60	2.60E-03	83.42%
159.15	2.36E-03	82.04%
174.20	2.50E-03	80.43%
189.25	2.19E-03	78.87%
206.80	2.48E-03	77.06%
226.85	2.58E-03	74.82%
246.90	2.13E-03	72.73%
276.95	1.58E-03	70.27%
317.00	7.60E-04	68.20%
367.05	1.41E-04	67.20%
427.10	0.00E+00	67.01%
487.15	0.00E+00	67.01%
577.20	0.00E+00	67.01%
697.25	0.00E+00	67.01%
817.30	0.00E+00	67.01%
937.35	0.00E+00	67.01%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3L	
Instruments:	VTS#03/GCMSD	
Date/Experiment #:	10/04/06	33
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	1	µL
Mass of agent disseminated:	1.01	mg
Corrected mass on 100% agent purity:	0.92	mg
Average substrate temperature:	50.12	°C
Average air flow rate:	405.44	SLPM
Average air temperature above drop:	50.02	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	96.3	%
Mass % recovery in vapor:	96.3	%
Tube #s consistant:	Yes	
Comments:	n/a	

Raw evaporation rate: 0.0032 mg/min

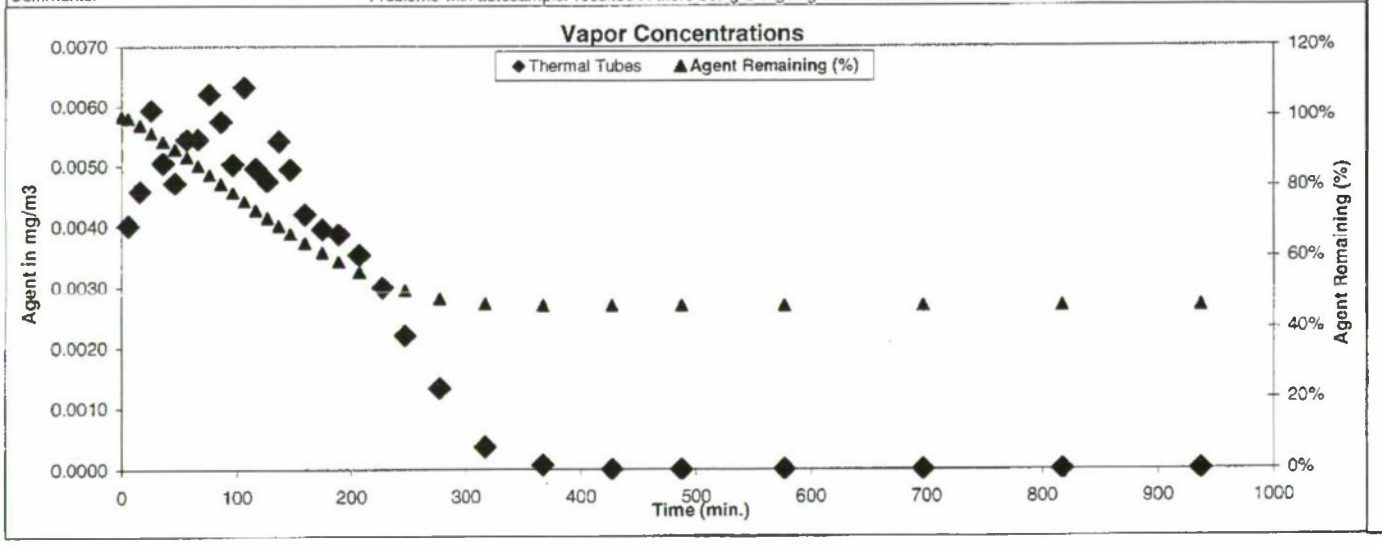


Time (min)	Conc. mg/m³	Agent rem. (%)
5.82	1.48E-02	98.10%
15.87	1.32E-02	91.88%
25.92	1.51E-02	85.61%
35.97	1.78E-02	78.31%
46.02	9.65E-03	72.22%
56.07	9.54E-03	67.97%
66.12	8.70E-03	63.93%
76.17	8.53E-03	60.11%
86.22	8.47E-03	56.34%
96.27	7.20E-03	52.87%
106.32	7.96E-03	49.51%
116.37	7.51E-03	48.08%
126.42	7.43E-03	42.77%
136.45	6.28E-03	39.73%
146.50	4.71E-03	37.30%
159.07	5.67E-03	34.42%
174.12	5.31E-03	30.77%
189.17	5.89E-03	27.06%
206.72	5.64E-03	22.60%
226.77	2.78E-03	18.87%
246.82	4.56E-03	15.63%
276.87	3.17E-03	10.51%
316.92	1.49E-03	6.38%
366.97	2.44E-04	4.46%
427.02	1.47E-04	3.95%
487.07	1.89E-05	3.73%
577.12	0.00E+00	3.69%
697.17	0.00E+00	3.69%
817.22	0.00E+00	3.69%
937.27	0.00E+00	3.69%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3L	
Instruments:	VTS#10/GCMSD	
Date/Experiment #:	10/05/06	34
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	1	µL
Mass of agent disseminated:	1.01	mg
Corrected mass on 100% agent purity:	0.92	mg
Average substrate temperature:	50.07	°C
Average air flow rate:	405.69	SLPM
Average air temperature above drop:	49.99	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	53.8	%
Mass % recovery in vapor:	53.8	%
Tube #s consistant:	Yes	
Comments:	Problems with autosampler resulted in there being 2 ongoing ccv's instead of usual 3.	

Raw evaporation rate: 0.0021 mg/min

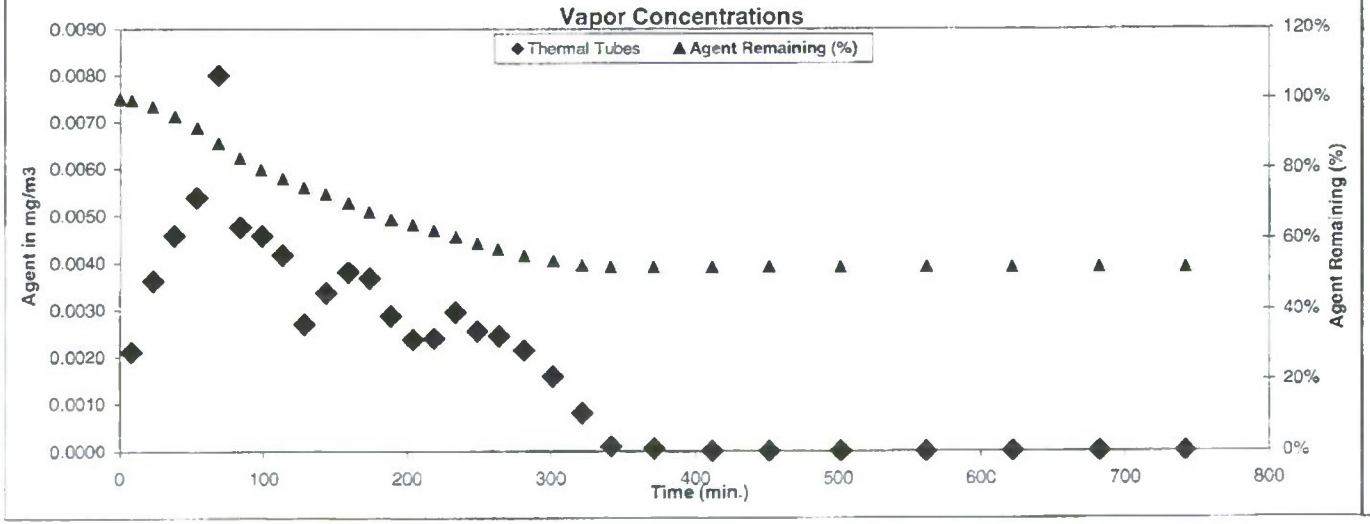


Time (min)	Conc. mg/m^3	Agent rem. (%)
5.93	4.02E-03	99.47%
15.98	4.58E-03	97.57%
26.03	5.94E-03	95.23%
36.08	5.06E-03	92.79%
46.13	4.72E-03	90.63%
56.18	5.45E-03	88.37%
66.23	5.45E-03	85.95%
76.28	6.21E-03	83.36%
86.33	5.75E-03	80.71%
96.38	5.03E-03	78.32%
106.43	6.32E-03	75.80%
116.48	4.96E-03	73.30%
126.53	4.75E-03	71.14%
136.58	5.42E-03	68.89%
146.63	4.95E-03	66.59%
159.18	4.21E-03	64.05%
174.23	3.96E-03	61.34%
189.28	3.88E-03	58.74%
206.83	3.54E-03	55.86%
226.88	3.00E-03	52.97%
246.93	2.21E-03	50.67%
276.98	1.33E-03	48.32%
317.03	3.71E-04	46.81%
367.08	7.44E-05	46.32%
427.13	0.00E+00	46.22%
487.18	0.00E+00	46.22%
577.23	0.00E+00	46.22%
697.28	0.00E+00	46.22%
817.33	0.00E+00	46.22%
937.38	0.00E+00	46.22%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	08/29/06	25
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	1	µL
Mass of agent disseminated:	1.01	mg
Corrected mass on 100% agent purity:	0.92	mg
Average substrate temperature:	50.21	°C
Average air flow rate:	405.62	SLPM
Average air temperature above drop:	50.27	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	48.0	%
Mass % recovery in vapor:	48.0	%
Tube #s consistant:	Yes	
Comments:	n/a	

Raw evaporation rate: 0.0021 mg/min



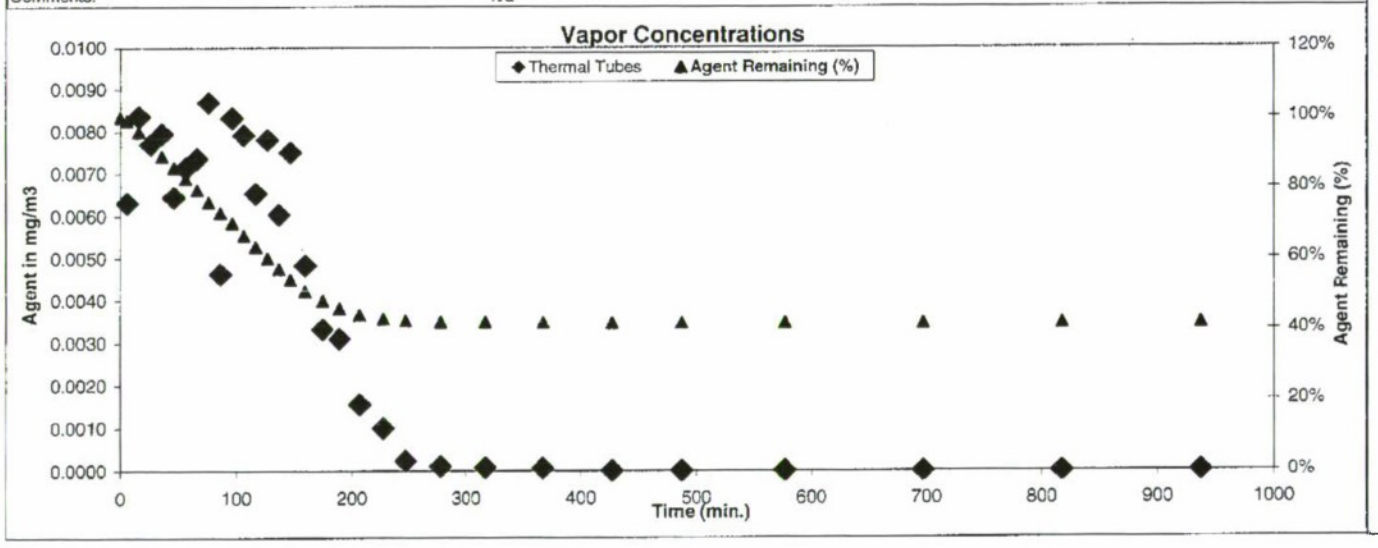
Time (min)	Conc. mg/m³	Agent rem. (%)
8.28	2.12E-03	99.61%
23.33	3.62E-03	97.71%
38.38	4.57E-03	94.98%
53.43	5.39E-03	91.67%
68.48	8.01E-03	87.22%
83.53	4.76E-03	82.98%
98.58	4.57E-03	79.88%
113.63	4.17E-03	76.98%
128.68	2.70E-03	74.70%
143.73	3.36E-03	72.68%
158.78	3.80E-03	70.30%
173.83	3.67E-03	67.82%
188.88	2.88E-03	65.65%
203.93	2.38E-03	63.90%
218.98	2.40E-03	62.32%
234.03	2.96E-03	60.53%
249.08	2.55E-03	58.70%
264.13	2.44E-03	57.05%
281.68	2.14E-03	55.27%
301.73	1.59E-03	53.62%
321.78	7.99E-04	52.57%
341.83	1.11E-04	52.17%
371.88	6.08E-05	52.05%
411.93	0.00E+00	52.00%
451.98	0.00E+00	52.00%
502.03	0.00E+00	52.00%
562.08	0.00E+00	52.00%
622.13	0.00E+00	52.00%
682.18	0.00E+00	52.00%
742.23	0.00E+00	52.00%

15 Copy of 20061004_3k_034(+ - +_a_4)VX_G.xls

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	10/04/06	34
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	1	µL
Mass of agent disseminated:	1.01	mg
Corrected mass on 100% agent purity:	0.92	mg
Average substrate temperature:	50.28	°C
Average air flow rate:	405.59	SLPM
Average air temperature above drop:	50.09	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	58.3	%
Mass % recovery in vapor:	58.3	%
Tube #s consistant:	Yes	
Comments:	n/a	

Raw evaporation rate: 0.0029 mg/min



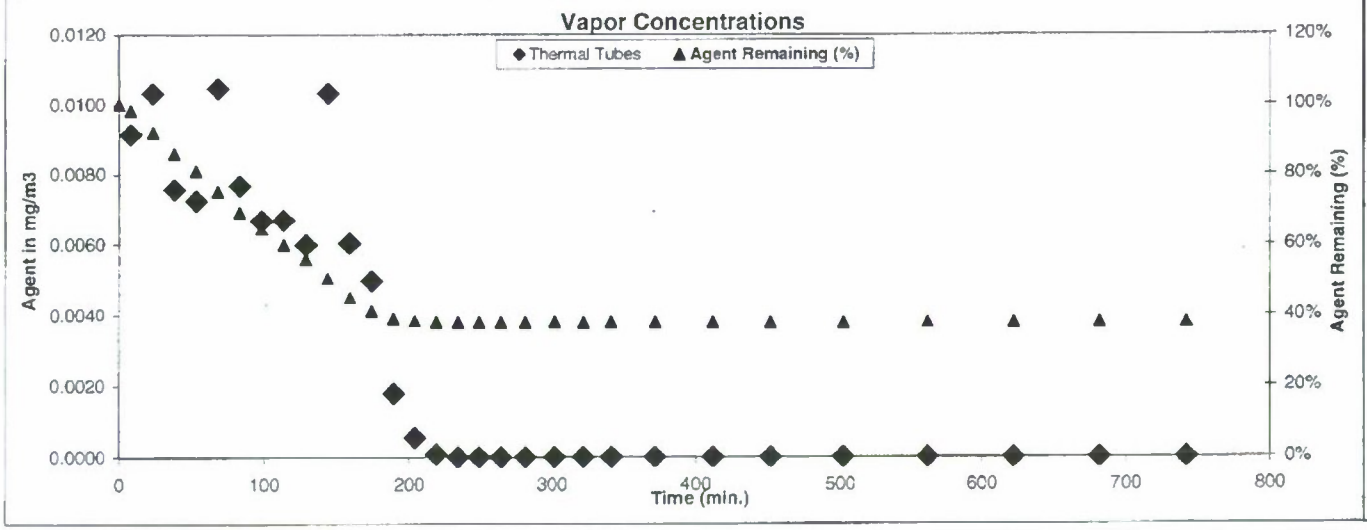
Time (min)	Conc. mg/m³	Agent rem. (%)
6.02	6.31E-03	99.16%
16.07	8.36E-03	95.91%
26.12	7.70E-03	92.35%
36.17	7.95E-03	88.88%
46.22	6.44E-03	85.69%
56.27	7.13E-03	82.68%
66.30	7.36E-03	79.47%
76.35	8.69E-03	75.92%
86.40	4.63E-03	72.96%
96.45	8.31E-03	70.09%
106.50	7.91E-03	66.49%
116.55	6.53E-03	63.29%
126.60	7.80E-03	60.11%
136.65	6.04E-03	57.05%
146.70	7.50E-03	54.04%
159.27	4.83E-03	50.62%
174.32	3.32E-03	47.92%
189.37	3.10E-03	45.78%
206.90	1.56E-03	43.98%
226.95	9.94E-04	42.85%
247.00	2.36E-04	42.31%
277.05	1.07E-04	42.08%
317.10	7.71E-05	41.92%
367.15	5.70E-05	41.77%
427.20	0.00E+00	41.69%
487.25	0.00E+00	41.69%
577.30	2.89E-06	41.69%
697.35	0.00E+00	41.68%
817.40	0.00E+00	41.68%
937.45	0.00E+00	41.68%

8 Copy of 20060906_3k_027(+ - +_a_3)VX_G.xls

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	09/06/06	27
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	1 µL	
Mass of agent disseminated:	1.01 mg	
Corrected mass on 100% agent purity:	0.92 mg	
Average substrate temperature:	50.53 °C	
Average air flow rate:	405.67 SLPM	
Average air temperature above drop:	49.91 °C	
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a %	
Total agent % mass recovery:	62.0 %	
Mass % recovery in vapor:	62.0 %	
Tube #s consistant:	Yes	
Comments:	n/a	

Raw evaporation rate: 0.0031 mg/min

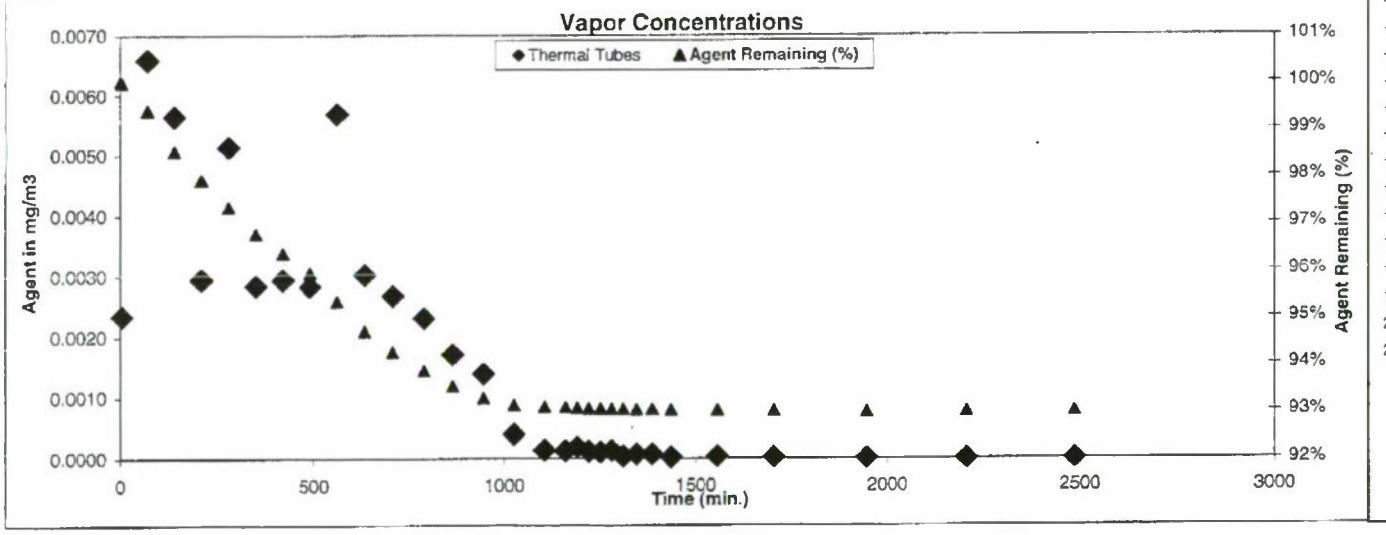


Time (min)	Conc. mg/m^3	Agent rem. (%)
8.25	9.13E-03	98.34%
23.30	1.03E-02	91.88%
38.35	7.54E-03	85.95%
53.40	7.23E-03	81.04%
68.45	1.05E-02	75.17%
83.48	7.65E-03	69.16%
98.53	6.67E-03	64.40%
113.58	6.69E-03	59.96%
128.63	5.99E-03	55.75%
143.68	1.03E-02	50.34%
158.73	6.03E-03	44.90%
173.78	4.95E-03	41.26%
188.83	1.79E-03	39.02%
203.88	5.47E-04	38.24%
218.93	9.06E-05	38.03%
234.00	0.00E+00	38.00%
249.05	0.00E+00	38.00%
264.10	0.00E+00	38.00%
281.65	0.00E+00	38.00%
301.70	0.00E+00	38.00%
321.73	0.00E+00	38.00%
341.78	0.00E+00	38.00%
371.83	1.17E-05	37.99%
411.88	0.00E+00	37.98%
451.93	0.00E+00	37.98%
501.98	0.00E+00	37.98%
562.03	0.00E+00	37.98%
622.08	0.00E+00	37.98%
682.13	0.00E+00	37.98%
742.18	0.00E+00	37.98%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	08/24/06	24
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	1	µL
Mass of agent disseminated:	1.01	mg
Corrected mass on 100% agent purity:	0.92	mg
Average substrate temperature:	50.44	°C
Average air flow rate:	18.74	SLPM
Average air temperature above drop:	49.97	°C
CCVs within criteria:	No	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	7.0	%
Mass % recovery in vapor:	7.0	%
Tube #s consistant:	Yes	
Comments:	3 of 3 ccvs outside current criteria	

Raw evaporation rate: 0.000068 mg/min



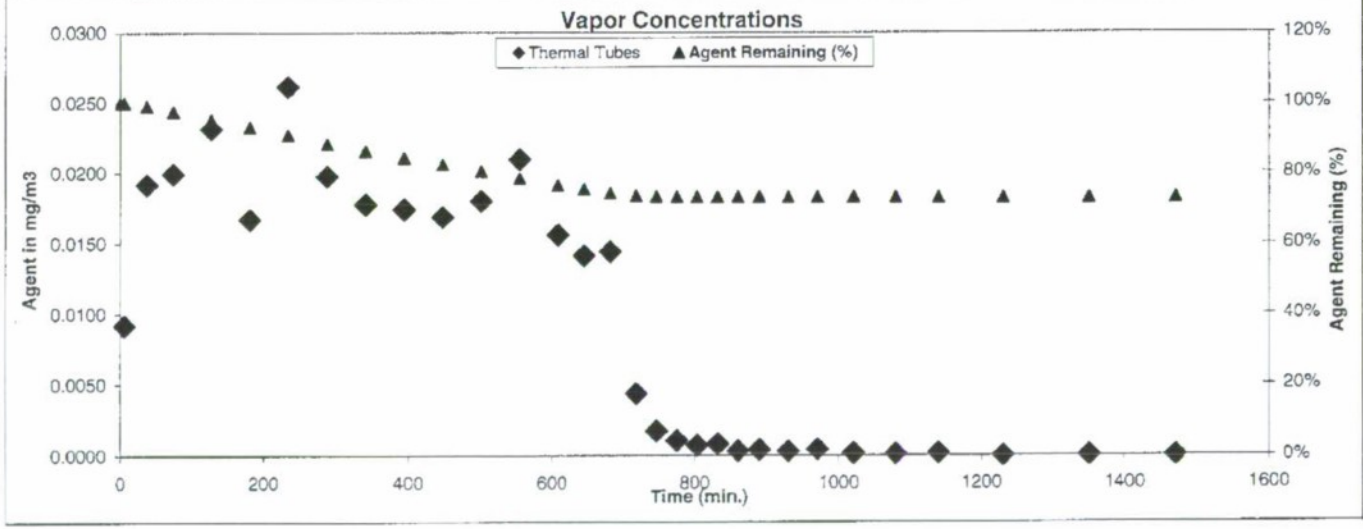
Time (min)	Conc. mg/m³	Agent rem. (%)
5.32	2.34E-03	99.99%
70.37	6.59E-03	99.40%
140.42	5.65E-03	98.52%
210.47	2.94E-03	97.91%
280.52	5.14E-03	97.33%
350.57	2.84E-03	96.76%
420.62	2.95E-03	96.35%
490.67	2.84E-03	95.93%
560.72	5.70E-03	95.32%
630.77	3.03E-03	94.70%
705.82	2.68E-03	94.26%
785.87	2.31E-03	93.86%
865.92	1.71E-03	93.53%
945.97	1.39E-03	93.28%
1026.02	4.03E-04	93.13%
1106.07	1.35E-04	93.09%
1161.12	1.29E-04	93.07%
1191.17	1.84E-04	93.06%
1221.22	1.22E-04	93.05%
1251.27	1.05E-04	93.04%
1281.32	1.28E-04	93.04%
1311.37	3.92E-05	93.03%
1346.42	6.87E-05	93.03%
1386.47	6.73E-05	93.02%
1436.52	2.06E-05	93.02%
1556.57	3.74E-05	93.01%
1706.62	2.18E-05	93.00%
1946.67	7.13E-06	93.00%
2206.72	1.59E-06	92.99%
2486.77	0.00E+00	92.99%

7 Copy of 20060831_3k_026(+ - -_a_1)VX_G.xls

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	08/31/06	26
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	1	µL
Mass of agent disseminated:	1.01	mg
Corrected mass on 100% agent purity:	0.92	mg
Average substrate temperature:	50.60	°C
Average air flow rate:	18.73	SLPM
Average air temperature above drop:	49.41	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	27.0	%
Mass % recovery in vapor:	27.0	%
Tube #s consistant:	Yes	
Comments:	n/a	

Raw evaporation rate: 0.00036 mg/min



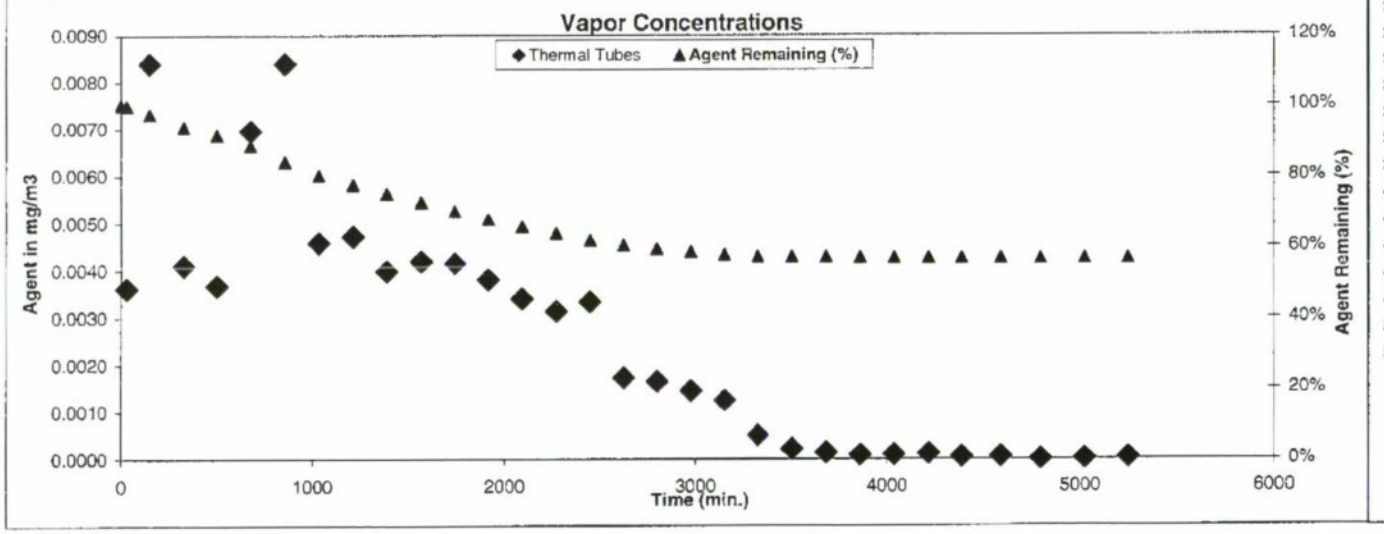
Time (min)	Conc. mg/m³	Agent rem. (%)
6.12	9.17E-03	99.94%
37.83	1.92E-02	99.03%
74.55	1.99E-02	97.57%
127.93	2.31E-02	95.22%
181.32	1.67E-02	93.06%
234.70	2.61E-02	90.73%
288.08	1.98E-02	88.23%
341.47	1.78E-02	86.19%
394.85	1.74E-02	84.28%
448.23	1.69E-02	82.41%
501.62	1.80E-02	80.51%
555.00	2.09E-02	78.40%
608.38	1.56E-02	76.41%
645.10	1.41E-02	75.30%
681.82	1.44E-02	74.23%
718.53	4.34E-03	73.53%
746.92	1.73E-03	73.36%
775.30	1.07E-03	73.28%
803.68	7.28E-04	73.22%
832.07	8.16E-04	73.18%
860.45	3.18E-04	73.15%
890.50	4.01E-04	73.12%
930.55	2.87E-04	73.10%
970.60	4.38E-04	73.07%
1020.65	1.69E-04	73.04%
1080.70	1.14E-04	73.02%
1140.75	1.56E-04	73.00%
1230.80	0.00E+00	72.99%
1350.85	2.44E-05	72.98%
1470.90	1.29E-05	72.98%

4 Copy of 20060817_3k_022(- 0 0_a_1)VX_G.xls

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	08/17/06	22
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	6	µL
Mass of agent disseminated:	6.06	mg
Corrected mass on 100% agent purity:	5.51	mg
Average substrate temperature:	34.54	°C
Average air flow rate:	181.69	SLPM
Average air temperature above drop:	34.55	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	43.3	%
Mass % recovery in vapor:	43.3	%
Tube #s consistant:	Yes	
Comments:	n/a	

Raw evaporation rate: 0.00103 mg/min

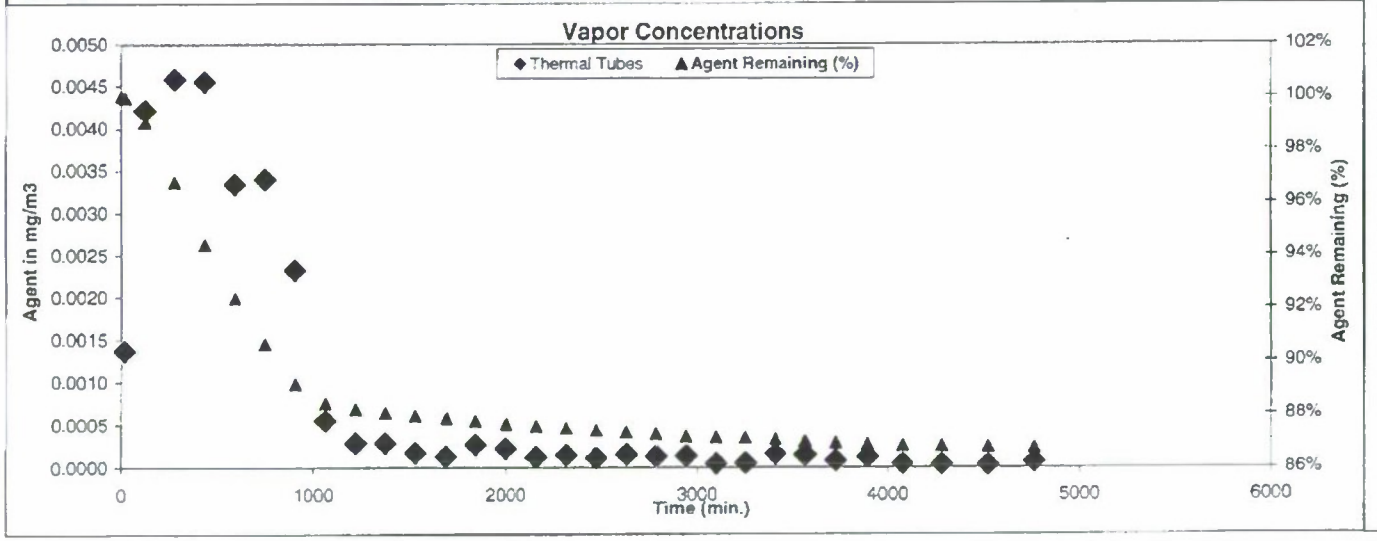


Time (min)	Conc. mg/m^3	Agent rem. (%)
30.45	3.61E-03	99.82%
150.50	8.39E-03	97.44%
327.22	4.10E-03	93.81%
503.93	3.68E-03	91.54%
680.65	6.95E-03	88.45%
857.37	8.39E-03	83.98%
1034.08	4.58E-03	80.21%
1210.80	4.72E-03	77.50%
1387.52	3.98E-03	74.96%
1564.23	4.19E-03	72.58%
1740.95	4.15E-03	70.15%
1917.67	3.81E-03	67.84%
2094.38	3.41E-03	65.73%
2271.10	3.14E-03	63.83%
2447.82	3.34E-03	61.94%
2624.53	1.73E-03	60.47%
2801.25	1.65E-03	59.48%
2977.97	1.45E-03	58.58%
3154.68	1.24E-03	57.80%
3331.40	5.11E-04	57.29%
3508.12	2.19E-04	57.08%
3684.83	1.37E-04	56.97%
3861.55	9.12E-05	56.91%
4038.27	9.44E-05	56.85%
4214.98	1.16E-04	56.79%
4388.37	5.23E-05	56.74%
4591.75	5.36E-05	56.71%
4798.47	9.90E-06	56.69%
5025.18	1.18E-05	56.68%
5251.90	3.35E-05	56.66%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3a
Instruments:	VTS#02/GCMSD
Date/Experiment #:	08/10/06 116
Type of substrate :	Glass
Test agent/purity:	VX_CASARM
Number of drops:	1
Nominal drop volume:	6 µL
Mass of agent disseminated:	6.06 mg
Corrected mass on 100% agent purity:	5.51 mg
Average substrate temperature:	34.64 °C
Average air flow rate:	181.88 SLPM
Average air temperature above drop:	35.14 °C
CCVs within criteria:	No
Mass % recovery by extraction:	n/a %
Total agent % mass recovery:	13.3 %
Mass % recovery in vapor:	13.3 %
Tube #s consistant:	Yes
Comments:	1 of 3 ccvs outside current criteria

Raw evaporation rate: 0.00075 mg/min

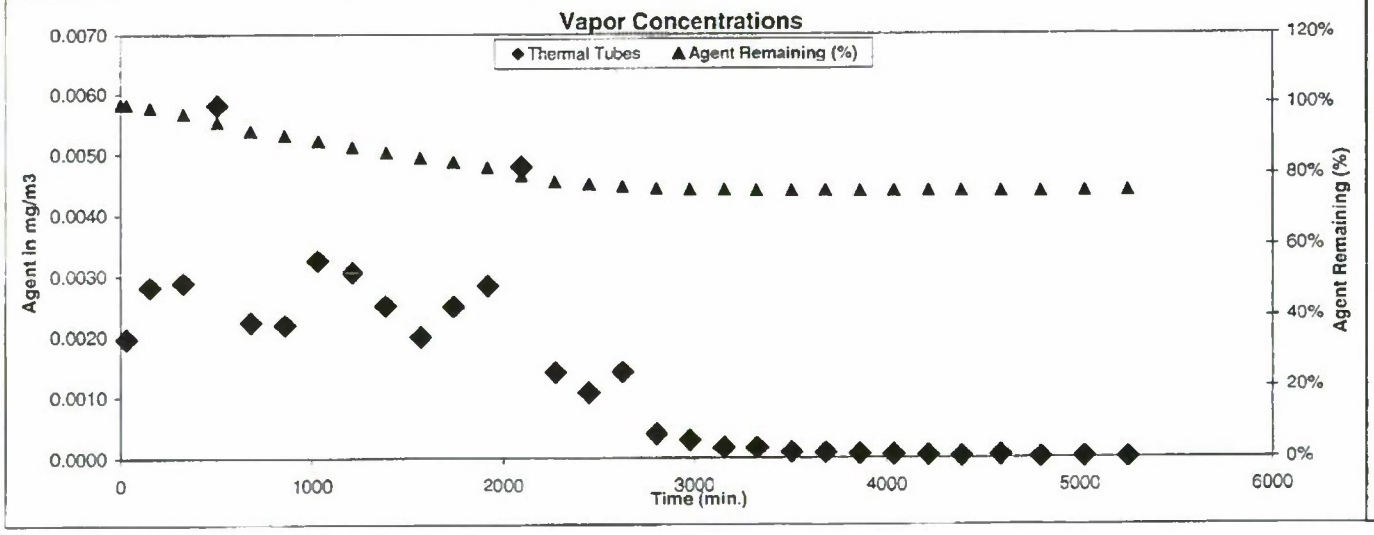


Time (min)	Conc. mg/m³	Agent rem. (%)
21.65	1.36E-03	99.95%
121.70	4.21E-03	99.03%
278.42	4.58E-03	96.76%
435.13	4.55E-03	94.40%
591.85	3.33E-03	92.36%
748.57	3.40E-03	90.62%
905.27	2.32E-03	89.15%
1061.98	5.48E-04	88.41%
1218.70	2.87E-04	88.19%
1375.42	2.85E-04	88.04%
1532.13	1.75E-04	87.92%
1688.85	1.28E-04	87.84%
1845.57	2.62E-04	87.74%
2002.28	2.24E-04	87.62%
2159.00	1.22E-04	87.53%
2315.72	1.42E-04	87.46%
2472.43	1.11E-04	87.40%
2629.15	1.52E-04	87.33%
2785.87	1.32E-04	87.25%
2942.57	1.35E-04	87.19%
3099.28	4.52E-05	87.14%
3256.00	5.23E-05	87.11%
3412.72	1.55E-04	87.06%
3569.43	1.47E-04	86.98%
3726.15	7.79E-05	86.92%
3896.20	1.20E-04	86.87%
4076.25	4.24E-05	86.82%
4286.30	3.52E-05	86.79%
4526.35	2.82E-05	86.77%
4766.38	6.29E-05	86.73%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3L	
Instruments:	VTS#03/GCMSD	
Date/Experiment #:	08/17/06	20
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	6	µL
Mass of agent disseminated:	6.06	mg
Corrected mass on 100% agent purity:	5.51	mg
Average substrate temperature:	35.38	°C
Average air flow rate:	181.57	SLPM
Average air temperature above drop:	34.78	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	24.8	%
Mass % recovery in vapor:	24.8	%
Tube #s consistant:	Yes	
Comments:	residue after evaporation was yellow to naked eye	

Raw evaporation rate: 0.00058 mg/min

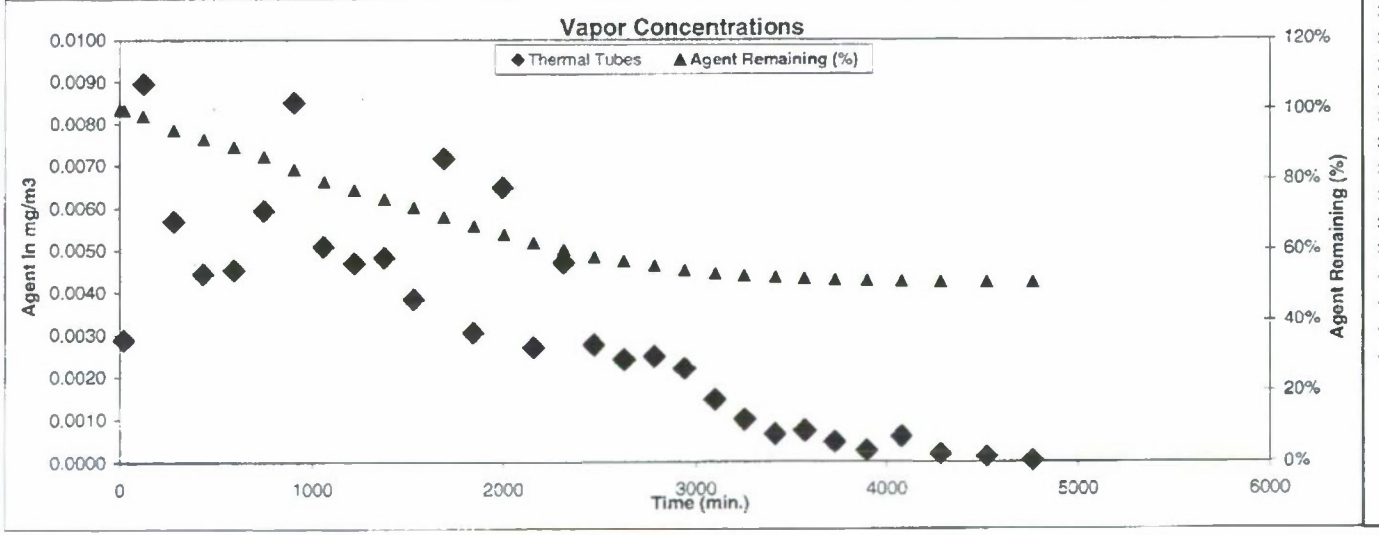


Time (min)	Conc. mg/m³	Agent rem. (%)
30.67	1.97E-03	99.90%
150.72	2.80E-03	98.96%
327.43	2.89E-03	97.30%
504.15	5.82E-03	94.77%
680.87	2.24E-03	92.43%
857.58	2.20E-03	91.14%
1034.30	3.26E-03	89.55%
1211.02	3.05E-03	87.71%
1387.73	2.51E-03	86.10%
1564.45	2.00E-03	84.78%
1741.17	2.50E-03	83.48%
1917.88	2.83E-03	81.92%
2094.60	4.79E-03	79.71%
2271.32	1.40E-03	77.91%
2448.03	1.07E-03	77.19%
2624.75	1.42E-03	76.46%
2801.47	3.89E-04	75.94%
2978.18	2.87E-04	75.74%
3154.90	1.70E-04	75.61%
3331.62	1.61E-04	75.51%
3508.33	9.32E-05	75.44%
3685.05	8.61E-05	75.38%
3861.77	6.69E-05	75.34%
4038.48	5.03E-05	75.30%
4215.20	4.09E-05	75.28%
4388.58	2.58E-05	75.26%
4591.97	4.61E-05	75.24%
4798.68	9.67E-06	75.22%
5025.40	1.76E-05	75.21%
5252.12	4.32E-06	75.20%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3c	
Instruments:	VTS#01/GCMSD	
Date/Experiment #:	08/10/06	158
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	6	µL
Mass of agent disseminated:	6.06	mg
Corrected mass on 100% agent purity:	5.51	mg
Average substrate temperature:	35.17	°C
Average air flow rate:	181.31	SLPM
Average air temperature above drop:	35.54	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	49.3	%
Mass % recovery in vapor:	49.3	%
Tube #s consistant:	Yes	
Comments:	n/a	

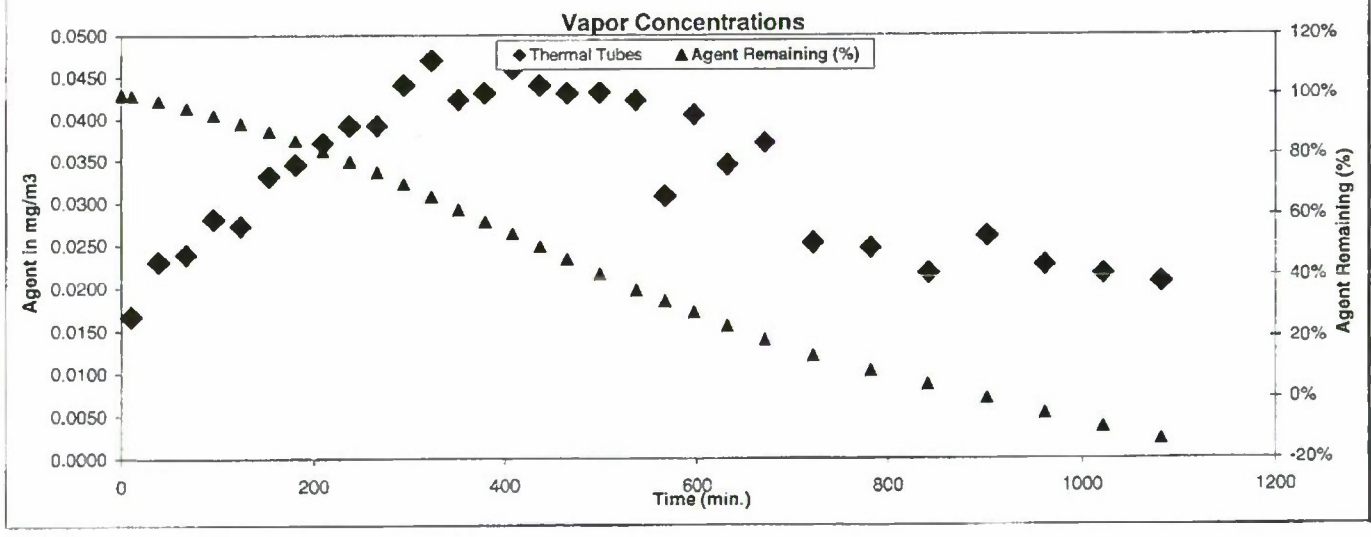
Raw evaporation rate: 0.0011 mg/min



Time (min)	Conc. mg/m^3	Agent rem. (%)
21.28	2.88E-03	99.90%
121.33	8.95E-03	97.95%
278.05	5.69E-03	94.18%
434.77	4.44E-03	91.57%
591.47	4.53E-03	89.26%
748.18	5.93E-03	86.56%
904.90	8.49E-03	82.85%
1061.62	5.08E-03	79.35%
1218.33	4.69E-03	76.83%
1375.05	4.82E-03	74.38%
1531.77	3.83E-03	72.15%
1688.48	7.17E-03	69.32%
1845.20	3.05E-03	66.68%
2001.92	6.48E-03	64.23%
2158.63	2.70E-03	61.86%
2315.35	4.70E-03	59.96%
2472.07	2.75E-03	58.04%
2628.78	2.41E-03	56.71%
2785.50	2.47E-03	55.45%
2942.22	2.19E-03	54.25%
3098.93	1.45E-03	53.31%
3255.65	9.88E-04	52.68%
3412.37	6.49E-04	52.26%
3569.08	7.34E-04	51.91%
3725.80	4.68E-04	51.60%
3895.85	2.61E-04	51.39%
4075.90	5.85E-04	51.14%
4285.95	1.86E-04	50.87%
4526.00	1.26E-04	50.75%
4766.05	3.97E-05	50.69%

Data Evaluation Grade: **Not For Modeling**

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	09/07/06	28
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	6 µL	
Mass of agent disseminated:	6.06 mg	
Corrected mass on 100% agent purity:	5.51 mg	
Average substrate temperature:	41.39 °C	
Average air flow rate:	181.67 SLPM	
Average air temperature above drop:	42.23 °C	
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a %	
Total agent % mass recovery:	113.8 %	
Mass % recovery in vapor:	113.8 %	Raw evaporation rate: 0.0072 mg/min
Tube #s consistant:	Yes	
Comments:	Last 10 sampling tubes are "saturated", so concentrations are not reliable.	

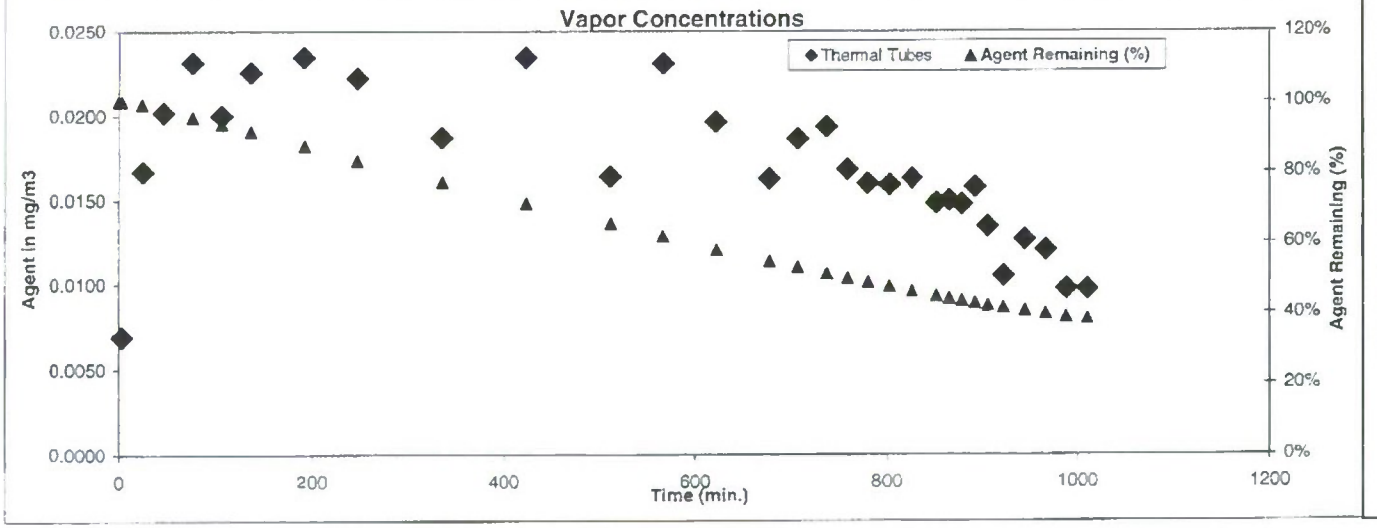


Time (min)	Conc. mg/m^3	Agent rem. (%)
10.58	1.67E-02	99.71%
38.97	2.31E-02	97.85%
67.35	2.39E-02	95.66%
95.73	2.81E-02	93.23%
124.12	2.73E-02	90.64%
152.50	3.31E-02	87.81%
180.88	3.45E-02	84.65%
209.25	3.71E-02	81.31%
237.63	3.92E-02	77.74%
266.02	3.92E-02	74.08%
294.40	4.41E-02	70.18%
322.78	4.70E-02	65.93%
351.17	4.23E-02	61.76%
379.55	4.31E-02	57.77%
407.93	4.60E-02	53.60%
436.33	4.40E-02	49.39%
464.72	4.31E-02	45.32%
498.08	4.31E-02	40.58%
536.47	4.22E-02	35.18%
566.52	3.08E-02	31.57%
596.57	4.04E-02	28.04%
631.62	3.45E-02	23.72%
671.67	3.71E-02	19.00%
721.72	2.53E-02	13.86%
781.77	2.46E-02	8.92%
841.82	2.17E-02	4.34%
901.87	2.60E-02	0.37%
961.92	2.27E-02	-5.19%
1021.97	2.16E-02	-9.57%
1082.02	2.07E-02	-13.75%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	10/03/06	33
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	6	µL
Mass of agent disseminated:	6.06	mg
Corrected mass on 100% agent purity:	5.51	mg
Average substrate temperature:	41.79	°C
Average air flow rate:	181.62	SLPM
Average air temperature above drop:	42.07	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	61.8	%
Mass % recovery in vapor:	61.8	%
Tube #s consistant:	Yes	
Comments:	n/a	

Raw evaporation rate: 0.0037 mg/min

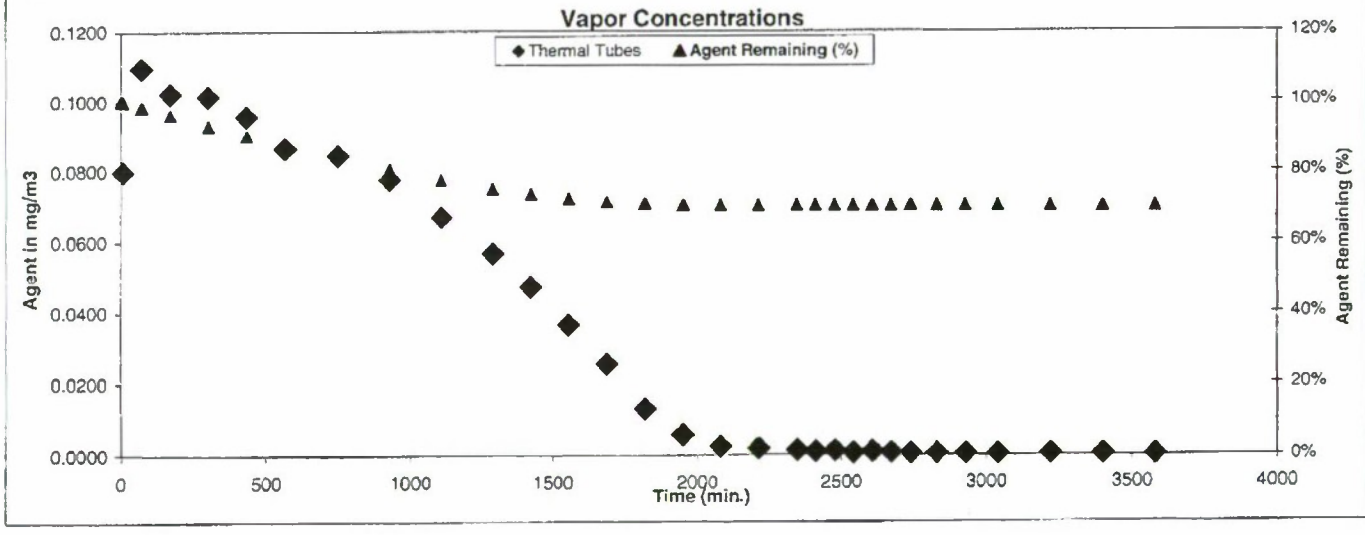


Time (min)	Conc. mg/m³	Agent rem. (%)
3.22	6.93E-03	99.96%
24.93	1.67E-02	99.12%
46.65	2.02E-02	97.80%
76.70	2.31E-02	95.65%
106.75	2.00E-02	93.52%
136.80	2.26E-02	91.41%
191.85	2.35E-02	87.24%
246.90	2.22E-02	83.10%
335.28	1.87E-02	77.14%
423.67	2.34E-02	71.02%
512.05	1.63E-02	65.23%
567.10	2.31E-02	61.66%
622.15	1.96E-02	57.79%
677.20	1.63E-02	54.53%
707.25	1.86E-02	52.81%
737.30	1.93E-02	50.93%
759.02	1.68E-02	49.64%
780.73	1.59E-02	48.47%
802.45	1.59E-02	47.33%
826.67	1.63E-02	46.05%
853.38	1.48E-02	44.68%
866.77	1.49E-02	44.03%
880.15	1.47E-02	43.37%
893.53	1.58E-02	42.70%
906.92	1.34E-02	42.06%
923.62	1.05E-02	41.40%
945.33	1.27E-02	40.57%
967.05	1.21E-02	39.69%
988.78	9.75E-03	38.91%
1010.50	9.72E-03	38.21%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	09/28/06	32
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	9	µL
Mass of agent disseminated:	9.09	mg
Corrected mass on 100% agent purity:	8.27	mg
Average substrate temperature:	50.07	°C
Average air flow rate:	18.78	SLPM
Average air temperature above drop:	49.40	°C
CCVs within criteria:	No	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	29.9	%
Mass % recovery in vapor:	29.9	%
Tube #s consistant:	Yes	
Comments:	1 of 3 ccvs outside current criteria. Several tubes were saturated or above calibration range- see TubeData! Column Q	

Raw evaporation rate: 0.0017 mg/min

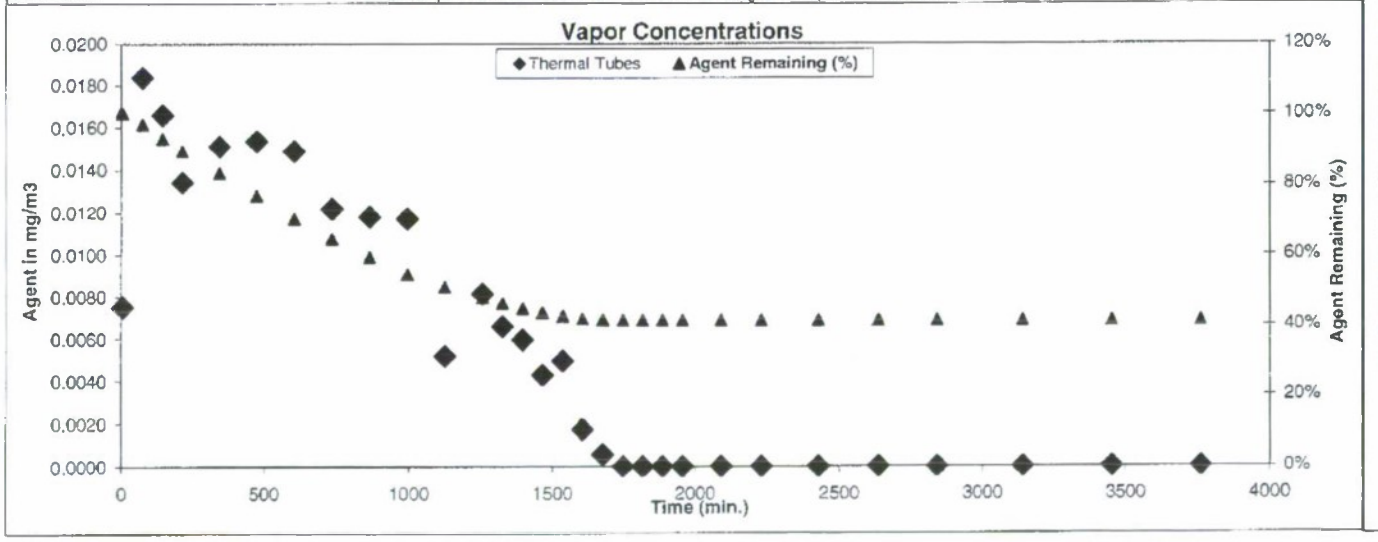


Time (min)	Conc. mg/m³	Agent rem. (%)
8.32	8.00E-02	99.92%
73.35	1.09E-01	98.53%
171.73	1.02E-01	96.16%
303.45	1.01E-01	93.11%
435.17	9.57E-02	90.17%
566.88	8.66E-02	87.44%
748.60	8.45E-02	83.91%
930.32	7.76E-02	80.57%
1112.03	6.70E-02	77.59%
1293.75	5.67E-02	75.04%
1425.47	4.72E-02	73.48%
1557.18	3.64E-02	72.23%
1688.90	2.55E-02	71.31%
1820.62	1.28E-02	70.74%
1952.33	5.67E-03	70.46%
2084.05	2.43E-03	70.34%
2215.77	1.70E-03	70.28%
2347.48	1.27E-03	70.23%
2412.53	9.06E-04	70.22%
2477.58	1.06E-03	70.20%
2542.63	5.62E-04	70.19%
2607.68	9.04E-04	70.18%
2672.73	5.20E-04	70.17%
2740.28	5.64E-04	70.16%
2830.33	4.99E-04	70.15%
2930.38	4.56E-04	70.14%
3040.43	3.97E-04	70.13%
3220.48	3.36E-04	70.11%
3400.53	2.52E-04	70.10%
3580.58	1.98E-04	70.09%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K	
Instruments:	VTS#C6/GCMSD	
Date/Experiment #:	10/16/06	38
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	6	µL
Mass of agent disseminated:	6.06	mg
Corrected mass on 100% agent purity:	5.51	mg
Average substrate temperature:	41.96	°C
Average air flow rate:	181.64	SLPM
Average air temperature above drop:	41.73	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	58.6	%
Mass % recovery in vapor:	58.6	%
Tube #s consistant:	Yes	
Comments:	Note temperature fluctuations at 2700 mins. are long after vapor concentration became insignificant	

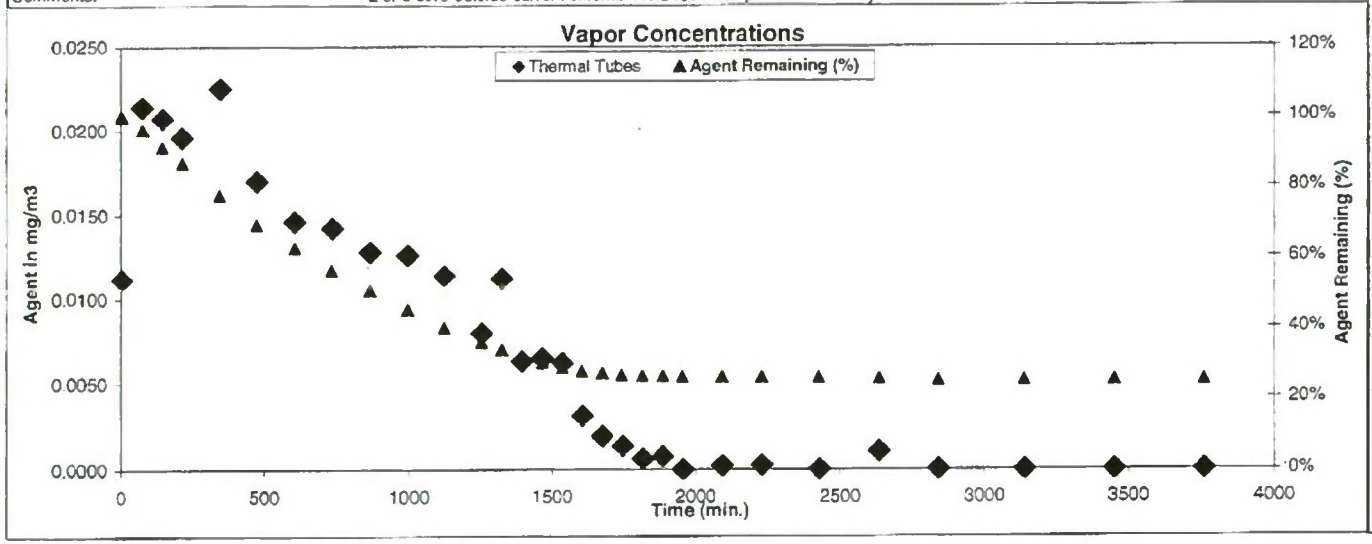
Raw evaporation rate: 0026 mg/min



Time (min)	Conc. mg/m³	Agent rem. (%)
5.82	7.54E-03	99.93%
75.87	1.84E-02	96.94%
145.92	1.66E-02	92.90%
215.97	1.34E-02	89.44%
346.02	1.51E-02	83.32%
476.07	1.54E-02	76.79%
606.10	1.49E-02	70.31%
736.15	1.22E-02	64.52%
866.20	1.18E-02	59.38%
996.25	1.17E-02	54.35%
1126.30	5.20E-03	50.73%
1256.35	8.14E-03	47.87%
1326.40	6.60E-03	46.17%
1396.45	5.95E-03	44.72%
1466.50	4.30E-03	43.54%
1536.55	4.97E-03	42.47%
1606.60	1.72E-03	41.70%
1676.65	5.61E-04	41.44%
1746.70	0.00E+00	41.37%
1816.75	0.00E+00	41.37%
1886.80	0.00E+00	41.37%
1956.85	0.00E+00	41.37%
2091.90	0.00E+00	41.37%
2231.95	0.00E+00	41.37%
2428.67	0.00E+00	41.37%
2635.38	0.00E+00	41.37%
2842.10	0.00E+00	41.37%
3142.15	0.00E+00	41.37%
3452.20	0.00E+00	41.37%
3762.25	0.00E+00	41.37%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3L	
Instruments:	VTS#10/GCMSD	
Date/Experiment #:	10/16/06	37
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	6 µL	
Mass of agent disseminated:	6.06 mg	
Corrected mass on 100% agent purity:	5.51 mg	
Average substrate temperature:	42.22 °C	
Average air flow rate:	181.51 SLPM	
Average air temperature above drop:	41.90 °C	
CCVs within criteria:	No	
Mass % recovery by extraction:	n/a %	
Total agent % mass recovery:	74.9 %	
Mass % recovery in vapor:	74.9 %	Raw evaporation rate: 0.0032 mg/min
Tube #s consistant:	Yes	
Comments:	2 of 3 ccvs outside current criteria. Note room temperature anomaly at 2800 mins	

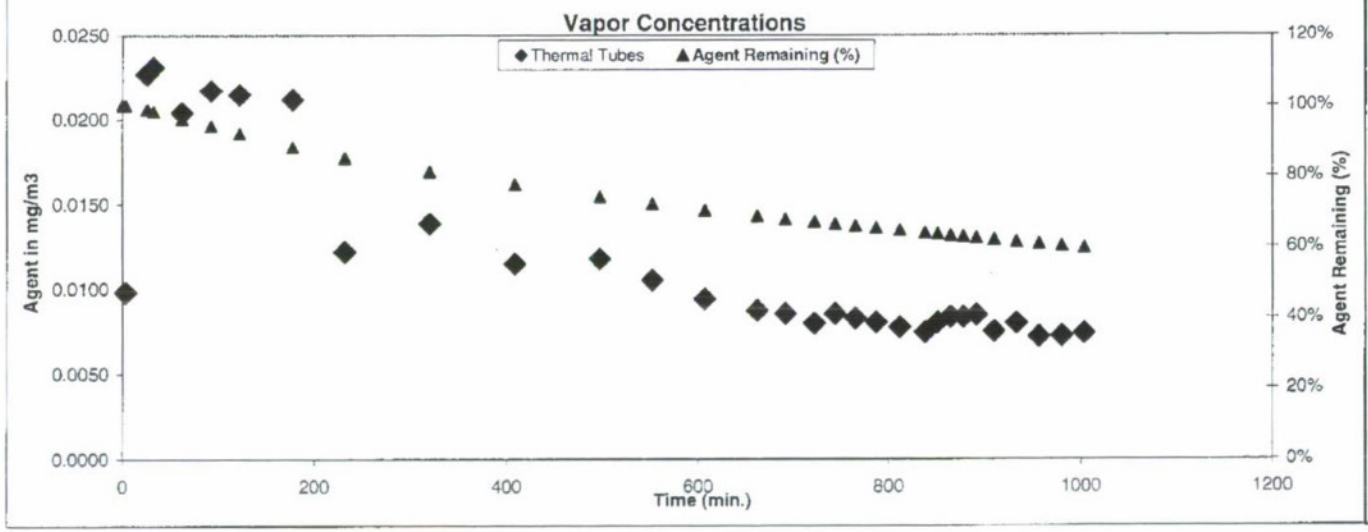


Time (min)	Conc. mg/m³	Agent rem. (%)
5.65	1.12E-02	99.90%
75.70	2.14E-02	96.14%
145.75	2.07E-02	91.29%
215.80	1.96E-02	86.65%
345.85	2.25E-02	77.64%
475.90	1.70E-02	69.19%
605.95	1.46E-02	62.43%
736.00	1.42E-02	56.26%
866.05	1.28E-02	50.48%
996.10	1.26E-02	45.04%
1126.15	1.14E-02	39.91%
1256.20	7.97E-03	35.77%
1326.25	1.12E-02	33.55%
1396.30	6.32E-03	31.53%
1466.35	6.49E-03	30.06%
1536.40	6.23E-03	28.59%
1606.45	3.14E-03	27.51%
1676.50	1.93E-03	26.92%
1746.55	1.35E-03	26.55%
1816.60	6.24E-04	26.32%
1886.65	7.47E-04	26.16%
1956.70	0.00E+00	26.07%
2091.75	2.00E-04	26.03%
2231.80	2.51E-04	25.93%
2428.52	0.00E+00	25.84%
2635.23	1.06E-03	25.48%
2841.95	0.00E+00	25.12%
3142.00	0.00E+00	25.12%
3452.05	0.00E+00	25.12%
3762.10	0.00E+00	25.12%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	09/26/07	31
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	6 µL	
Mass of agent disseminated:	6.06 mg	
Corrected mass on 100% agent purity:	5.51 mg	
Average substrate temperature:	42.19 °C	
Average air flow rate:	181.65 SLPM	
Average air temperature above drop:	41.87 °C	
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a %	
Total agent % mass recovery:	40.3 %	
Mass % recovery in vapor:	40.3 %	
Tube #s consistant:	Yes	
Comments:	n/a	

Raw evaporation rate: 0.0037 mg/min



Time (min)	Conc. mg/m^3	Agent rem. (%)
3.17	9.81E-03	99.95%
24.88	2.27E-02	98.79%
31.60	2.31E-02	98.28%
61.65	2.04E-02	96.13%
91.70	2.17E-02	94.04%
121.75	2.15E-02	91.91%
176.80	2.12E-02	88.04%
231.85	1.22E-02	85.02%
320.23	1.39E-02	81.23%
408.62	1.15E-02	77.54%
497.00	1.18E-02	74.15%
552.05	1.05E-02	72.12%
607.10	9.41E-03	70.31%
662.15	8.74E-03	68.67%
692.20	8.56E-03	67.81%
722.25	7.96E-03	66.99%
743.97	8.54E-03	66.40%
765.68	8.28E-03	65.80%
787.40	8.04E-03	65.22%
811.62	7.74E-03	64.59%
838.33	7.44E-03	63.92%
851.72	8.03E-03	63.58%
865.10	8.34E-03	63.22%
878.48	8.34E-03	62.85%
891.87	8.49E-03	62.48%
910.25	7.49E-03	61.99%
933.63	7.99E-03	61.40%
957.02	7.20E-03	60.81%
980.38	7.22E-03	60.26%
1003.77	7.41E-03	59.69%

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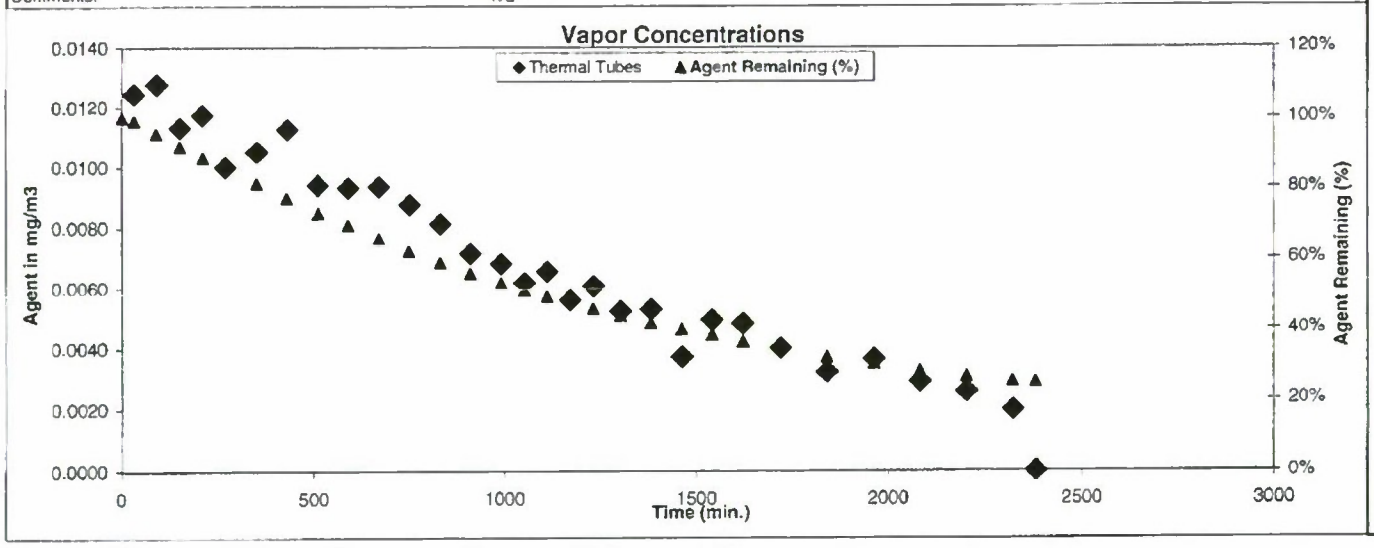
Data Evaluation Grade: **Modeling Grade**

Tunnel:	3L	
Instruments:	VTS#03/GCMSD	
Date/Experiment #:	09/11/06	27
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	9	µL
Mass of agent disseminated:	9.09	mg
Corrected mass on 100% agent purity:	8.27	mg
Average substrate temperature:	34.73	°C
Average air flow rate:	405.43	SLPM
Average air temperature above drop:	34.92	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	75.3	%
Mass % recovery in vapor:	75.3	%
Tube #s consistant:	Yes	
Comments:	n/a	

Raw evaporation rate: 0.0039 mg/min

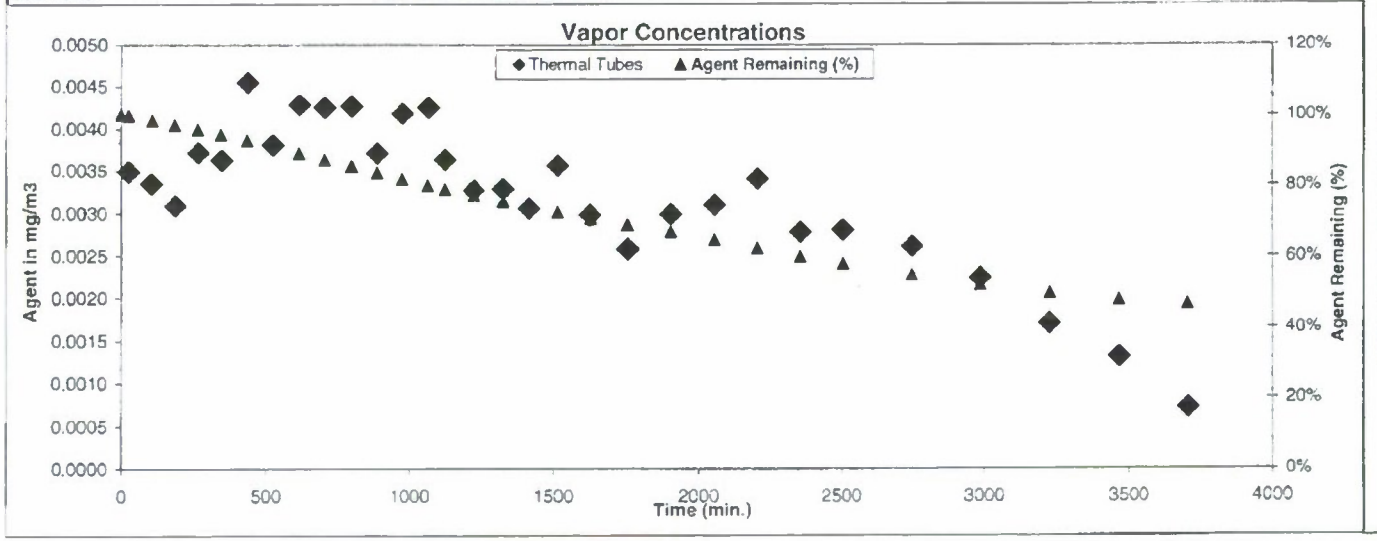


Time (min)	Conc. mg/m³	Agent rem. (%)
30.87	1.25E-02	99.06%
90.92	1.28E-02	95.34%
150.97	1.13E-02	91.80%
211.02	1.17E-02	88.40%
271.07	1.00E-02	85.20%
351.12	1.05E-02	81.17%
431.17	1.13E-02	76.89%
511.22	9.41E-03	72.84%
591.27	9.32E-03	69.16%
671.32	9.35E-03	65.50%
751.37	8.77E-03	61.95%
831.42	8.13E-03	58.63%
911.47	7.15E-03	55.63%
991.52	6.81E-03	52.89%
1051.57	6.18E-03	50.98%
1111.62	6.54E-03	49.11%
1171.67	5.61E-03	47.32%
1231.72	6.07E-03	45.60%
1301.77	5.24E-03	43.66%
1381.82	5.30E-03	41.59%
1461.87	3.72E-03	39.83%
1541.92	4.95E-03	38.13%
1621.97	4.82E-03	36.21%
1722.02	4.00E-03	34.05%
1842.07	3.22E-03	31.92%
1962.12	3.65E-03	29.90%
2082.17	2.91E-03	27.97%
2202.22	2.60E-03	26.35%
2322.27	2.00E-03	25.00%
2382.32	0.00E+00	24.70%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3L	
Instruments:	VTS#03/GCMSD	
Date/Experiment #:	09/28/06	31
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	9	µL
Mass of agent disseminated:	9.09	mg
Corrected mass on 100% agent purity:	8.27	mg
Average substrate temperature:	34.72	°C
Average air flow rate:	405.38	SLPM
Average air temperature above drop:	34.91	°C
CCVs within criteria:	No	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	53.5	%
Mass % recovery in vapor:	53.5	%
Tube #s consistant:	Yes	
Comments:	3 of 3 ccvs outside current criteria	

Raw evaporation rate: 0.0014 mg/min

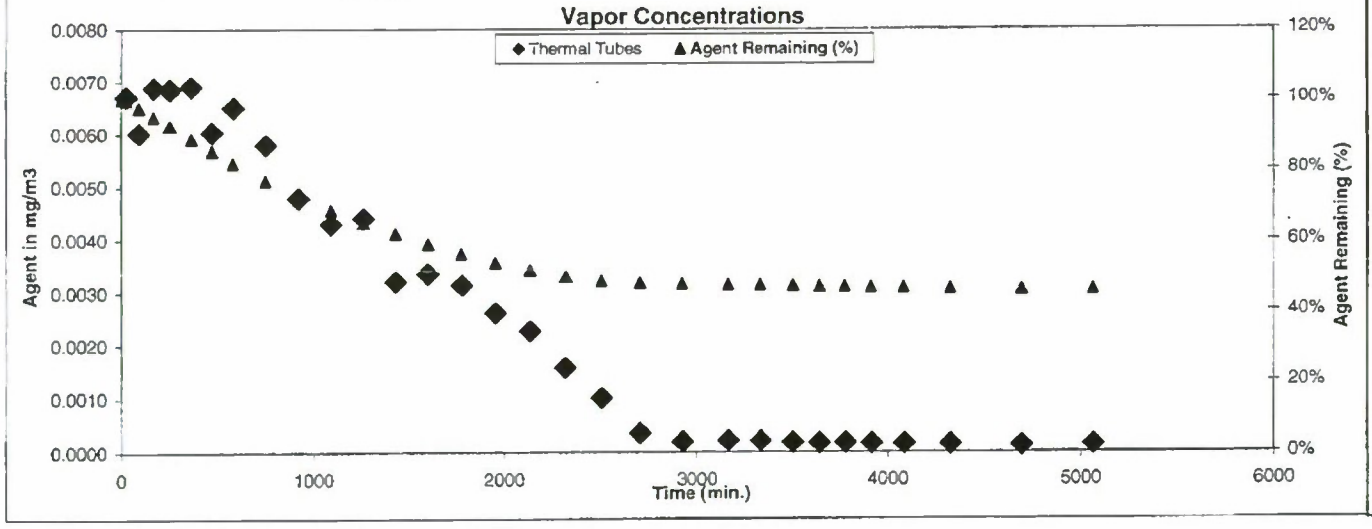


Time (min)	Conc. mg/m³	Agent rem. (%)
25.73	3.49E-03	99.78%
105.78	3.35E-03	98.44%
185.83	3.08E-03	97.18%
265.88	3.71E-03	95.85%
345.93	3.62E-03	94.41%
435.98	4.54E-03	92.61%
526.03	3.80E-03	90.76%
616.08	4.29E-03	88.98%
706.13	4.26E-03	87.10%
796.18	4.27E-03	85.22%
886.23	3.72E-03	83.45%
976.28	4.18E-03	81.71%
1066.33	4.25E-03	79.85%
1125.38	3.63E-03	78.71%
1225.43	3.27E-03	77.02%
1325.48	3.29E-03	75.41%
1415.53	3.06E-03	74.01%
1515.58	3.56E-03	72.38%
1625.63	2.98E-03	70.62%
1755.68	2.58E-03	68.85%
1905.73	2.99E-03	66.80%
2055.78	3.10E-03	64.56%
2205.83	3.41E-03	62.17%
2355.88	2.78E-03	59.89%
2505.93	2.80E-03	57.84%
2745.98	2.61E-03	54.66%
2986.03	2.24E-03	51.80%
3226.08	1.71E-03	49.48%
3466.13	1.31E-03	47.70%
3706.18	7.08E-04	46.51%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3L	
Instruments:	VTS#10/GCMSD	
Date/Experiment #:	10/19/06	38
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	9	µL
Mass of agent disseminated:	9.09	mg
Corrected mass on 100% agent purity:	8.27	mg
Average substrate temperature:	34.93	°C
Average air flow rate:	405.04	SLPM
Average air temperature above drop:	34.71	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	54.2	%
Mass % recovery in vapor:	54.2	%
Tube #s consistant:	Yes	
Comments:	Disturbance to flow control starting at about 1600 minutes - at roughly half the amplitude of sister run 3K039	

Raw evaporation rate: 0.0025 mg/min

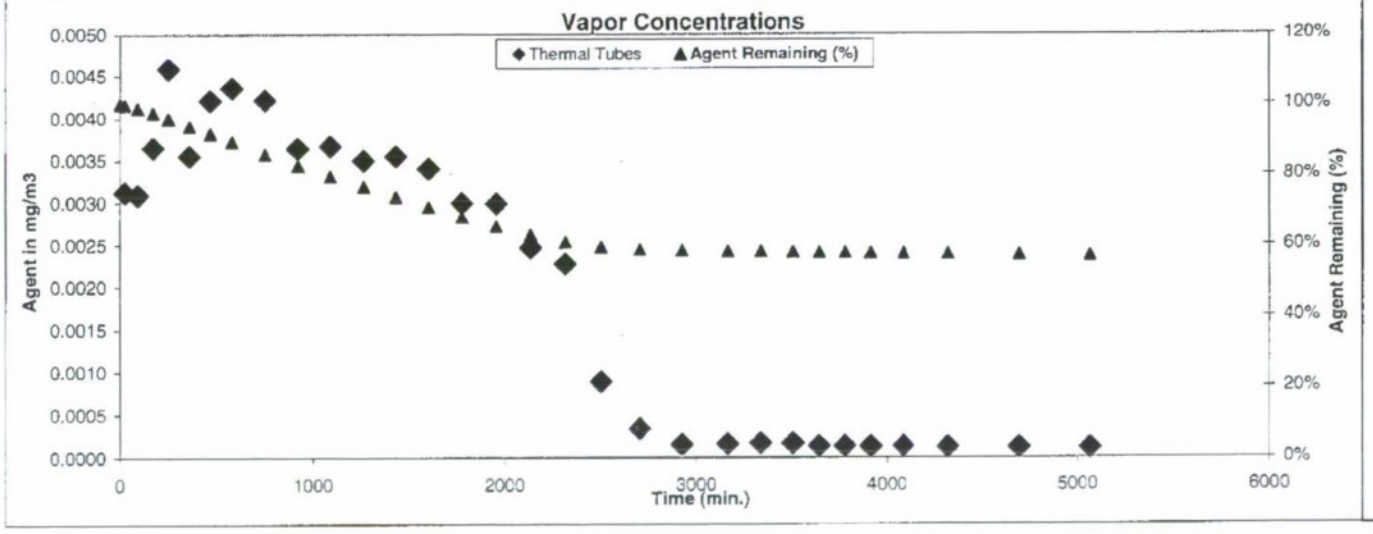


Time (min)	Conc. mg/m³	Agent rem. (%)
25.22	6.71E-03	99.59%
90.27	6.01E-03	97.56%
170.32	6.88E-03	95.03%
250.37	6.85E-03	92.34%
360.42	6.90E-03	88.64%
470.47	6.03E-03	85.16%
580.52	6.50E-03	81.78%
750.55	5.78E-03	76.67%
920.60	4.78E-03	72.27%
1090.65	4.29E-03	68.49%
1260.70	4.41E-03	64.87%
1430.75	3.22E-03	61.69%
1600.80	3.36E-03	58.96%
1775.85	3.15E-03	56.17%
1955.90	2.61E-03	53.63%
2135.97	2.26E-03	51.48%
2316.00	1.58E-03	49.79%
2506.05	1.00E-03	48.59%
2706.10	3.63E-04	47.92%
2926.15	2.01E-04	47.61%
3166.20	2.16E-04	47.37%
3336.25	2.13E-04	47.19%
3506.30	1.88E-04	47.02%
3643.02	1.74E-04	46.90%
3779.73	1.82E-04	46.78%
3916.45	1.72E-04	46.66%
4086.50	1.65E-04	46.52%
4326.55	1.54E-04	46.34%
4696.60	1.29E-04	46.08%
5066.65	1.47E-04	45.83%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	10/19/06	39
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	9	µL
Mass of agent disseminated:	9.09	mg
Corrected mass on 100% agent purity:	8.27	mg
Average substrate temperature:	35.55	°C
Average air flow rate:	404.08	SLPM
Average air temperature above drop:	34.71	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	43.0	%
Mass % recovery in vapor:	43.0	%
Tube #s consistant:	Yes	
Comments:	Perturbations to flow control begin to occur at 1600 minutes. Note also minor temperature fluctuations	

Raw evaporation rate: 0.0015 mg/min

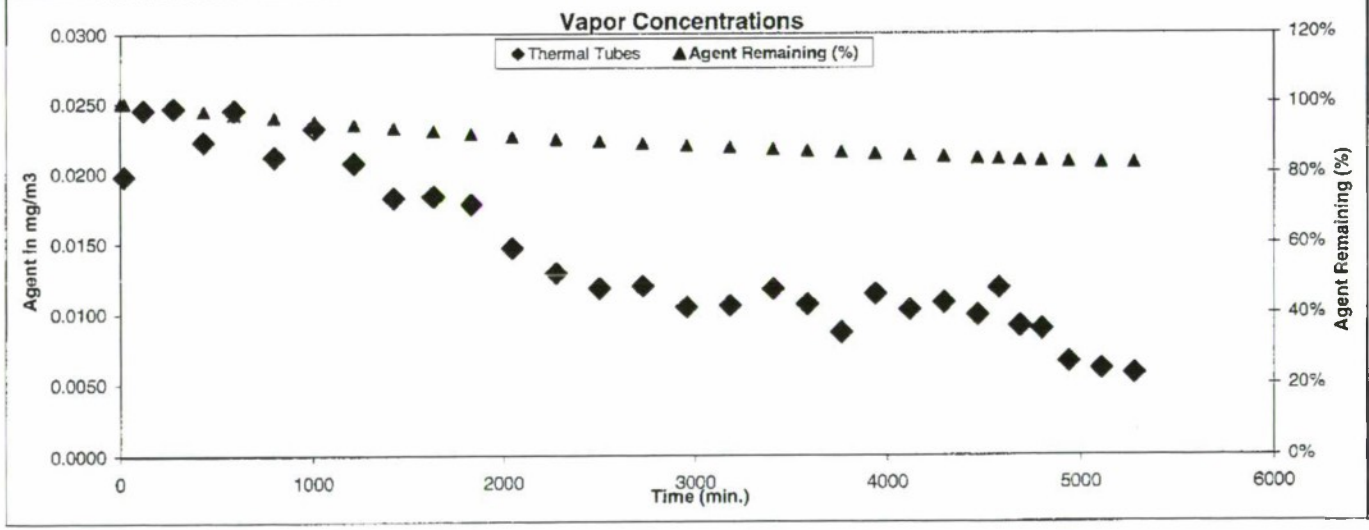


Time (min)	Conc. mg/m³	Agent rem. (%)
25.77	3.12E-03	99.80%
90.82	3.09E-03	98.82%
170.87	3.65E-03	97.50%
250.92	4.59E-03	95.89%
360.97	3.55E-03	93.70%
471.02	4.21E-03	91.62%
581.07	4.36E-03	89.32%
751.12	4.21E-03	85.76%
921.17	3.64E-03	82.49%
1091.22	3.67E-03	79.46%
1261.27	3.50E-03	76.48%
1431.32	3.55E-03	73.56%
1601.37	3.40E-03	70.67%
1776.42	2.99E-03	67.94%
1956.47	2.99E-03	65.31%
2136.52	2.47E-03	62.91%
2316.57	2.28E-03	60.82%
2506.62	8.90E-04	59.35%
2706.67	3.39E-04	58.75%
2926.72	1.57E-04	58.48%
3166.77	1.61E-04	58.29%
3336.82	1.69E-04	58.16%
3506.87	1.64E-04	58.02%
3643.58	1.38E-04	57.92%
3780.30	1.35E-04	57.83%
3917.02	1.32E-04	57.74%
4087.07	1.36E-04	57.63%
4327.12	1.25E-04	57.47%
4697.17	1.20E-04	57.25%
5067.22	1.15E-04	57.04%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3L	
Instruments:	VTS#03/GCMSD	
Date/Experiment #:	09/14/06	29
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	9	µL
Mass of agent disseminated:	9.09	mg
Corrected mass on 100% agent purity:	8.27	mg
Average substrate temperature:	35.49	°C
Average air flow rate:	18.74	SLPM
Average air temperature above drop:	34.88	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	17.3	%
Mass % recovery in vapor:	17.3	%
Tube #s consistant:	Yes	
Comments:	n/a	

Raw evaporation rate: 0.00039 mg/min

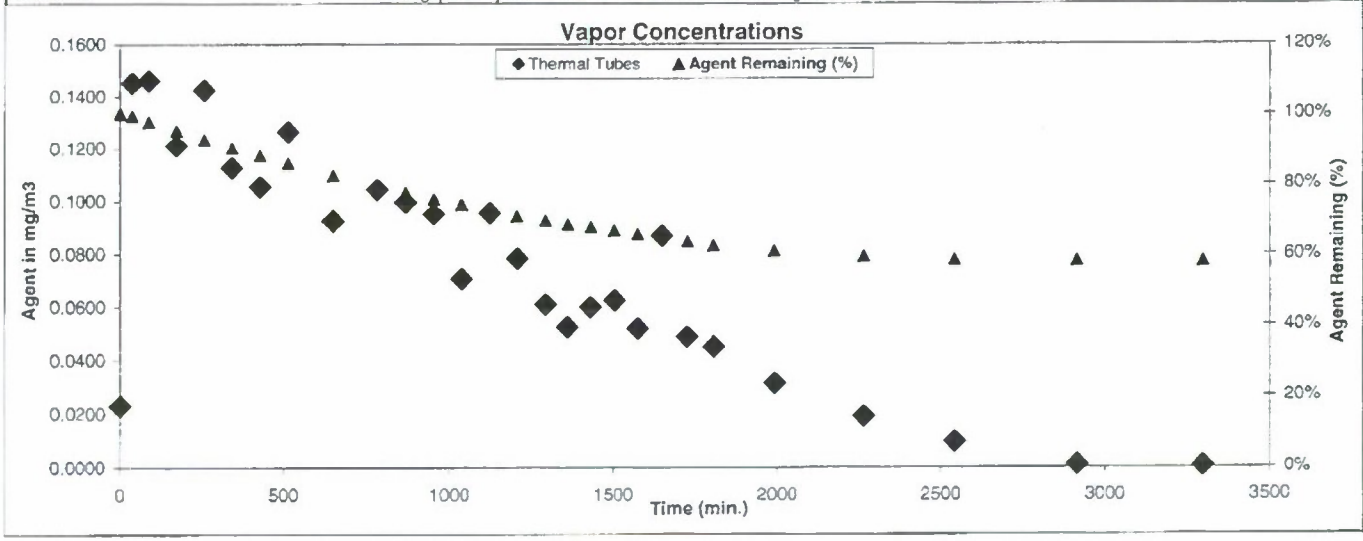


Time (min)	Conc. mg/m³	Agent rem. (%)
20.67	1.98E-02	99.95%
120.72	2.45E-02	99.45%
277.43	2.46E-02	98.58%
434.15	2.22E-02	97.75%
590.87	2.45E-02	96.92%
797.57	2.12E-02	95.85%
1004.28	2.32E-02	94.81%
1211.00	2.07E-02	93.78%
1417.72	1.83E-02	92.87%
1624.43	1.84E-02	92.01%
1831.15	1.78E-02	91.16%
2047.87	1.47E-02	90.36%
2274.58	1.29E-02	89.66%
2501.30	1.18E-02	89.02%
2728.02	1.20E-02	88.41%
2954.75	1.05E-02	87.83%
3181.47	1.05E-02	87.29%
3408.17	1.17E-02	86.72%
3584.88	1.07E-02	86.27%
3761.60	8.68E-03	85.89%
3938.32	1.14E-02	85.49%
4115.03	1.03E-02	85.05%
4291.75	1.08E-02	84.63%
4468.47	9.87E-03	84.22%
4578.52	1.18E-02	83.95%
4688.57	9.11E-03	83.69%
4798.62	8.90E-03	83.46%
4938.67	6.60E-03	83.22%
5108.72	6.09E-03	82.97%
5278.77	5.75E-03	82.74%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3L	
Instruments:	VTS#10/GCMSD	
Date/Experiment #:	10/06/06	35
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	9	µL
Mass of agent disseminated:	9.09	mg
Corrected mass on 100% agent purity:	8.27	mg
Average substrate temperature:	50.66	°C
Average air flow rate:	18.67	SLPM
Average air temperature above drop:	49.89	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	42.0	%
Mass % recovery in vapor:	42.0	%
Tube #s consistant:	Yes	
Comments:	Notice gaps for cycles 11 and 15 are due to malfunctioning autosampler. A consequence is two instead of three ccv's	

Raw evaporation rate: 0.0020 mg/m.in

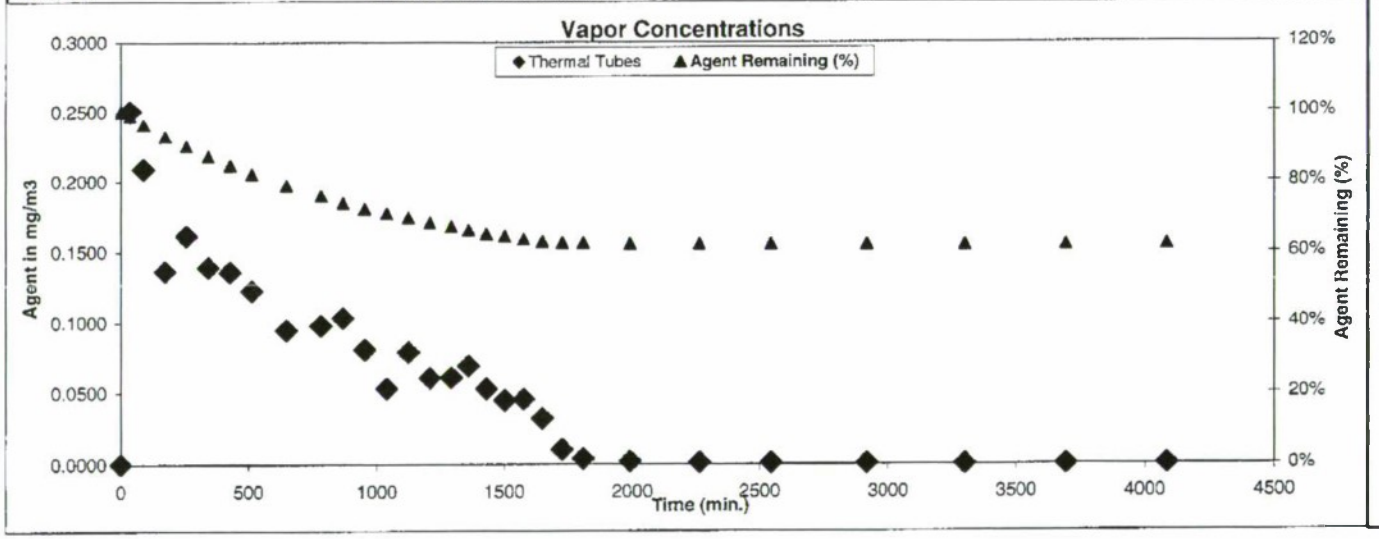


Time (min)	Conc. mg/m³	Agent rem. (%)
1.50	2.28E-02	100.00%
36.55	1.45E-01	99.33%
88.27	1.46E-01	97.63%
173.32	1.21E-01	95.07%
258.37	1.42E-01	92.54%
343.42	1.13E-01	90.09%
428.45	1.05E-01	88.00%
513.50	1.27E-01	85.77%
648.55	9.27E-02	82.43%
783.60	1.04E-01	79.43%
868.65	9.96E-02	77.47%
953.70	9.51E-02	75.60%
1038.75	7.07E-02	74.01%
1123.80	9.56E-02	72.41%
1208.85	7.84E-02	70.75%
1293.90	6.11E-02	69.41%
1362.28	5.23E-02	68.53%
1431.50	5.98E-02	67.66%
1503.22	6.25E-02	66.67%
1576.60	5.21E-02	65.72%
1649.98	8.71E-02	64.57%
1727.53	4.88E-02	63.38%
1809.25	4.50E-02	62.51%
1993.47	3.14E-02	60.92%
2263.52	1.90E-02	59.38%
2543.57	9.38E-03	58.49%
2916.95	9.43E-04	58.05%
3300.33	4.88E-04	57.99%
0.00	1.54E-04	0.00%
0.00	0.00E+00	0.00%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K
Instruments:	VTS#06/GCMSD
Date/Experiment #:	10/12/06 36
Type of substrate :	Glass
Test agent/purity:	VX_CASARM
Number of drops:	1
Nominal drop volume:	9 µL
Mass of agent disseminated:	9.09 mg
Corrected mass on 100% agent purity:	8.27 mg
Average substrate temperature:	49.56 °C
Average air flow rate:	18.66 SLPM
Average air temperature above drop:	48.91 °C
CCVs within criteria:	No
Mass % recovery by extraction:	n/a %
Total agent % mass recovery:	37.9 %
Mass % recovery in vapor:	37.9 %
Tube #s consistant:	Yes
Comments:	2 of 3 ccvs outside current criteria

Raw evaporation rate: 0.0027 mg/min

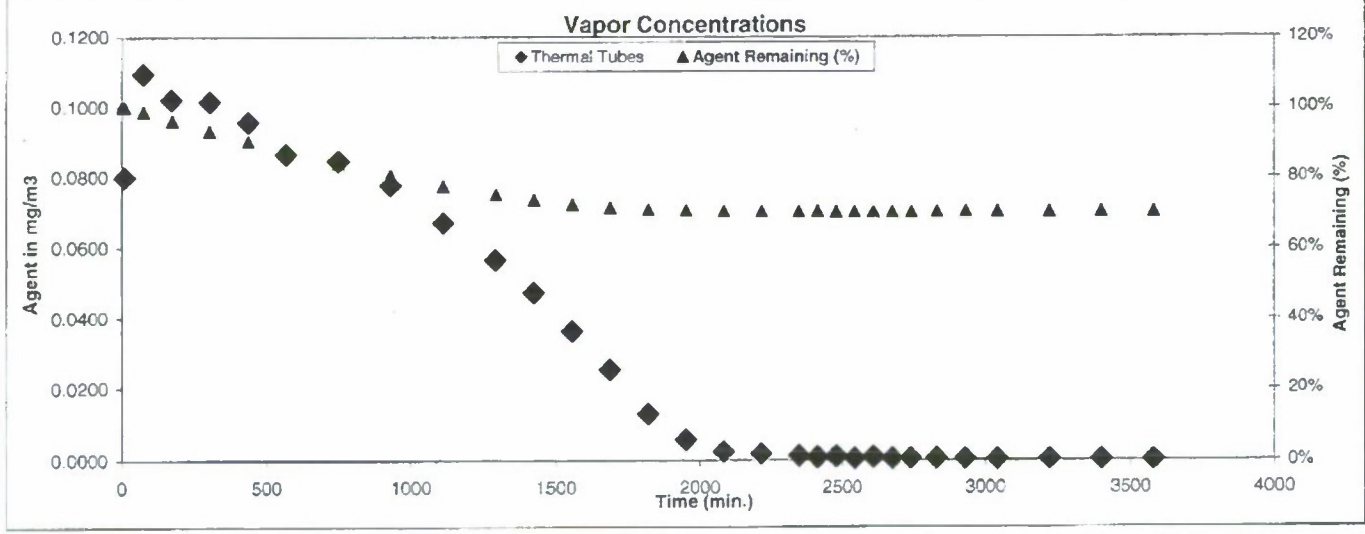


Time (min)	Conc. mg/m^3	Agent rem. (%)
1.65	0.00E+00	100.00%
36.70	2.50E-01	99.01%
88.42	2.09E-01	96.33%
173.47	1.36E-01	93.02%
258.52	1.61E-01	90.16%
343.57	1.39E-01	87.28%
428.62	1.36E-01	84.64%
513.67	1.23E-01	82.16%
648.72	9.47E-02	78.85%
783.77	9.79E-02	75.91%
868.82	1.03E-01	73.98%
953.87	8.09E-02	72.22%
1038.92	5.32E-02	70.93%
1123.97	7.90E-02	69.66%
1209.02	6.08E-02	68.32%
1294.07	6.09E-02	67.15%
1362.45	6.93E-02	66.15%
1431.66	5.29E-02	65.20%
1503.38	4.49E-02	64.40%
1576.77	4.55E-02	63.66%
1650.15	3.19E-02	63.02%
1727.70	1.03E-02	62.65%
1809.42	4.11E-03	62.51%
1993.63	2.12E-03	62.38%
2263.68	1.43E-03	62.28%
2543.73	9.16E-04	62.20%
2917.12	5.96E-04	62.14%
3300.48	2.54E-04	62.10%
3693.87	2.23E-04	62.08%
4087.25	1.42E-04	62.06%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3K	
Instruments:	VTS#06/GCMSD	
Date/Experiment #:	09/28/06	32
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	9	µL
Mass of agent disseminated:	9.09	mg
Corrected mass on 100% agent purity:	8.27	mg
Average substrate temperature:	50.07	°C
Average air flow rate:	18.78	SLPM
Average air temperature above drop:	49.40	°C
CCVs within criteria:	No	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	29.9	%
Mass % recovery in vapor:	29.9	%
Tube #s consistant:	Yes	
Comments:	1 of 3 ccvs outside current criteria. Several tubes were saturated or above calibration range- see TubeData! Column Q	

Raw evaporation rate: 0.0017 mg/min

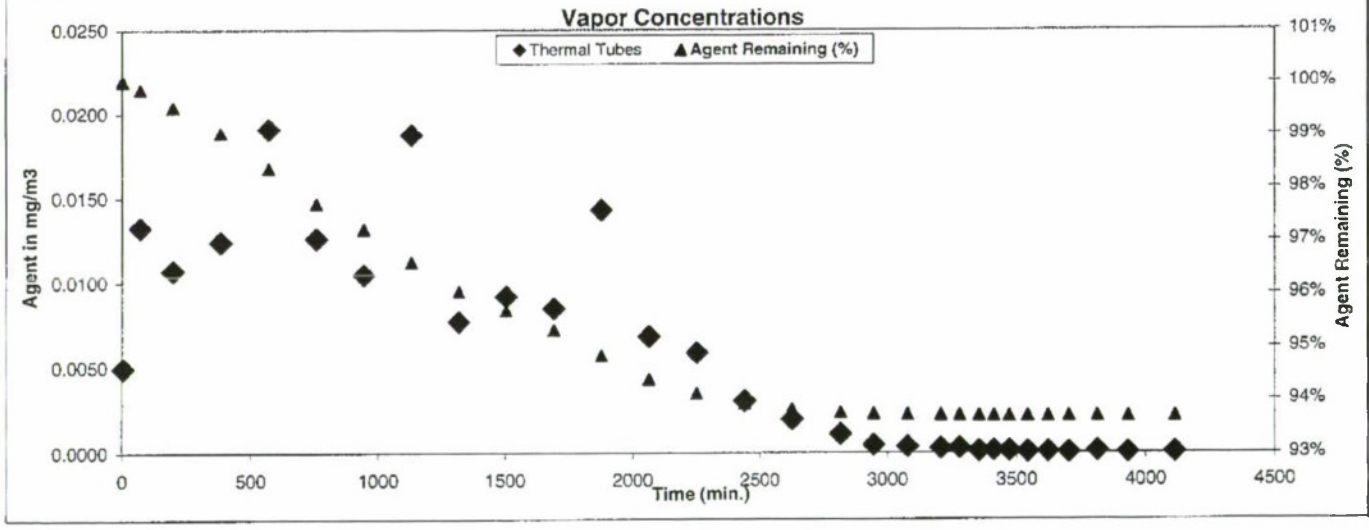


Time (min)	Conc. mg/m^3	Agent rem. (%)
8.32	8.00E-02	99.92%
73.35	1.09E-01	98.53%
171.73	1.02E-01	96.16%
303.45	1.01E-01	93.11%
435.17	9.57E-02	90.17%
566.88	8.66E-02	87.44%
748.60	8.45E-02	83.91%
930.32	7.76E-02	80.57%
1112.03	6.70E-02	77.59%
1293.75	5.67E-02	75.04%
1425.47	4.72E-02	73.48%
1557.18	3.64E-02	72.23%
1688.90	2.55E-02	71.31%
1820.62	1.28E-02	70.74%
1952.33	5.67E-03	70.46%
2084.05	2.43E-03	70.34%
2215.77	1.70E-03	70.28%
2347.48	1.27E-03	70.23%
2412.53	9.06E-04	70.22%
2477.58	1.06E-03	70.20%
2542.63	5.62E-04	70.19%
2607.68	9.04E-04	70.18%
2672.73	5.20E-04	70.17%
2740.28	5.64E-04	70.16%
2830.33	4.99E-04	70.15%
2930.38	4.56E-04	70.14%
3040.43	3.97E-04	70.13%
3220.48	3.36E-04	70.11%
3400.53	2.52E-04	70.10%
3580.58	1.98E-04	70.09%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3L	
Instruments:	VTS#03/GCMSD	
Date/Experiment #:	08/25/06	22
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	9	µL
Mass of agent disseminated:	9.09	mg
Corrected mass on 100% agent purity:	8.27	mg
Average substrate temperature:	50.47	°C
Average air flow rate:	18.69	SLPM
Average air temperature above drop:	49.81	°C
CCVs within criteria:	No	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	6.3	%
Mass % recovery in vapor:	6.3	%
Tube #s consistant:	Yes	
Comments:	1 of 3 ccvs outside current criteria	

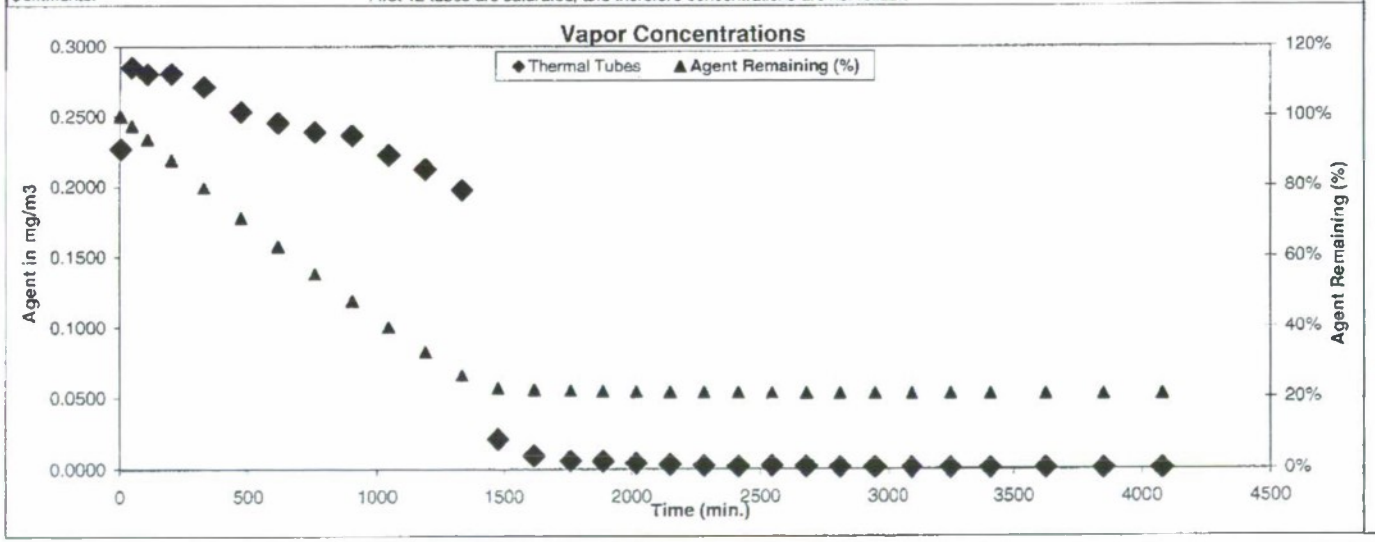
Raw evaporation rate: 0.00026 mg/min



Time (min)	Conc. mg/m^3	Agent rem. (%)
5.00	4.95E-03	100.00%
71.72	1.32E-02	99.86%
198.43	1.07E-02	99.52%
385.15	1.24E-02	99.03%
571.87	1.91E-02	98.37%
758.59	1.26E-02	97.70%
945.30	1.05E-02	97.21%
1132.02	1.87E-02	96.59%
1318.74	7.71E-03	96.04%
1505.45	9.20E-03	95.68%
1692.17	8.49E-03	95.31%
1878.88	1.43E-02	94.83%
2065.60	6.83E-03	94.38%
2252.32	5.89E-03	94.11%
2439.04	3.01E-03	93.92%
2627.42	1.96E-03	93.82%
2817.47	1.09E-03	93.75%
2947.52	4.53E-04	93.73%
3077.57	3.60E-04	93.72%
3207.62	2.73E-04	93.71%
3280.17	2.80E-04	93.70%
3355.22	9.09E-05	93.70%
3412.77	1.47E-04	93.70%
3472.82	1.41E-04	93.70%
3542.87	5.76E-05	93.70%
3622.92	7.43E-05	93.69%
3702.97	3.67E-05	93.69%
3813.02	1.06E-04	93.69%
3933.07	2.41E-05	93.69%
4113.12	4.12E-05	93.69%

Data Evaluation Grade: Not For Modelling

Tunnel:	3L	
Instruments:	VTS#03/GCMSD	
Date/Experiment #:	09/07/06	26
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	9 µL	
Mass of agent disseminated:	9.09 mg	
Corrected mass on 100% agent purity:	8.27 mg	
Average substrate temperature:	50.57 °C	
Average air flow rate:	18.72 SLPM	
Average air temperature above drop:	49.78 °C	
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a %	
Total agent % mass recovery:	79.0 %	
Mass % recovery in vapor:	79.0 %	Raw evaporation rate: 0.0047 mg/min
Tube #s consistant:	Yes	
Comments:	First 12 tubes are saturated, and therefore concentrations are not reliable	

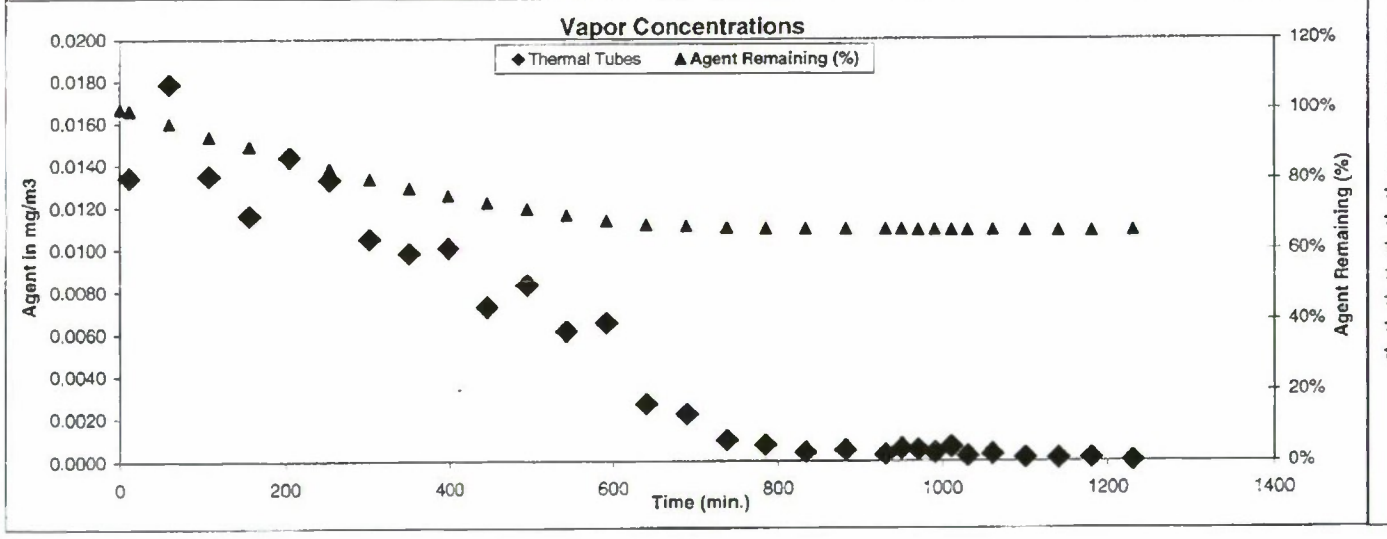


Time (min)	Conc. mg/m³	Agent rem. (%)
5.58	2.27E-01	99.86%
48.97	2.85E-01	97.34%
109.02	2.80E-01	93.50%
202.40	2.81E-01	87.57%
329.12	2.71E-01	79.66%
472.50	2.53E-01	71.15%
615.88	2.45E-01	63.06%
759.27	2.39E-01	55.20%
902.65	2.36E-01	47.48%
1046.03	2.22E-01	40.04%
1189.42	2.12E-01	32.99%
1332.80	1.98E-01	26.34%
1476.18	2.11E-02	22.78%
1619.57	9.45E-03	22.29%
1762.95	5.78E-03	22.04%
1889.67	5.65E-03	21.88%
2018.88	4.40E-03	21.73%
2150.60	3.31E-03	21.62%
2282.32	2.56E-03	21.53%
2414.03	2.14E-03	21.46%
2545.75	2.25E-03	21.39%
2677.47	1.87E-03	21.33%
2811.68	1.46E-03	21.28%
2948.40	1.34E-03	21.24%
3095.12	1.03E-03	21.20%
3251.83	9.00E-04	21.16%
3408.55	8.08E-04	21.13%
3625.27	6.64E-04	21.10%
3851.98	4.87E-04	21.07%
4078.70	4.41E-04	21.04%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3L	
Instruments:	VTS#03/GCMSD	
Date/Experiment #:	08/21/06	21
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	9 µL	
Mass of agent disseminated:	9.09 mg	
Corrected mass on 100% agent purity:	8.27 mg	
Average substrate temperature:	50.09 °C	
Average air flow rate:	405.39 SLPM	
Average air temperature above drop:	50.22 °C	
CCVs within criteria:	No	
Mass % recovery by extraction:	n/a %	
Total agent % mass recovery:	34.8 %	
Mass % recovery in vapor:	34.8 %	
Tube #s consistant:	Yes	
Comments:	1 of 3 ccvs outside current criteria	

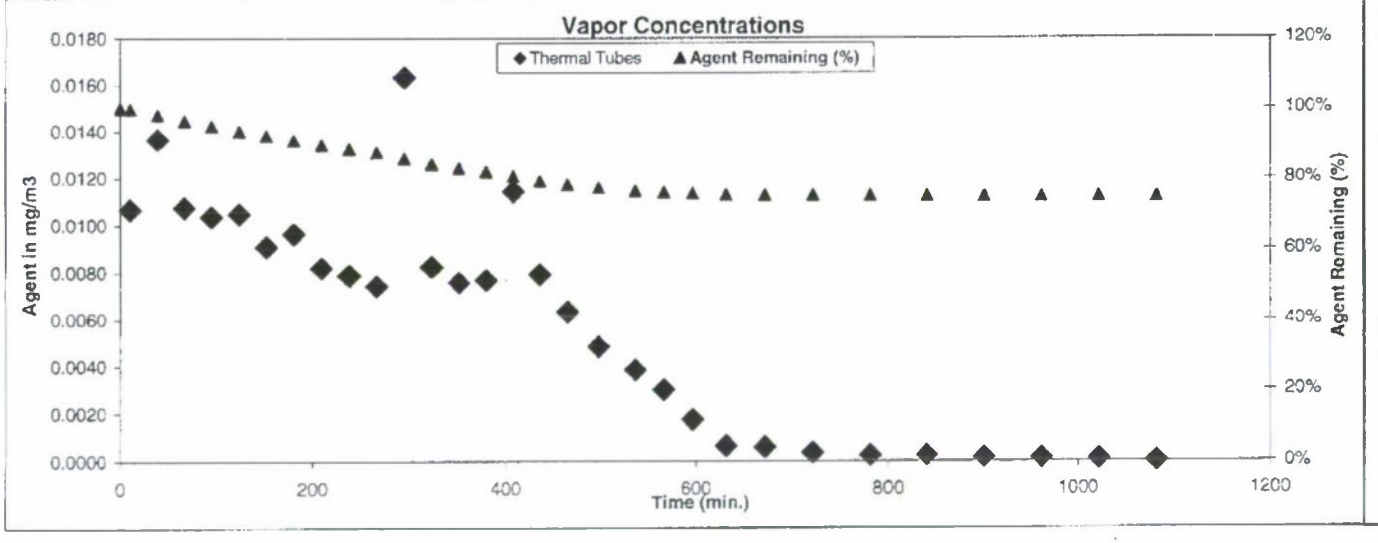
Raw evaporation rate: 0.0050 mg/min



Time (min)	Conc. mg/m³	Agent rem. (%)
11.13	1.34E-02	99.63%
59.52	1.79E-02	95.93%
107.90	1.35E-02	92.21%
156.28	1.16E-02	89.24%
204.67	1.43E-02	86.17%
253.05	1.33E-02	82.89%
301.43	1.05E-02	80.07%
349.82	9.81E-03	77.67%
398.20	1.01E-02	75.31%
446.58	7.30E-03	73.25%
494.97	8.32E-03	71.40%
543.35	6.13E-03	69.69%
591.73	6.52E-03	68.19%
640.12	2.69E-03	67.09%
688.50	2.21E-03	66.51%
736.88	9.80E-04	66.14%
785.27	7.53E-04	65.93%
833.65	4.19E-04	65.79%
882.03	5.24E-04	65.68%
930.42	3.15E-04	65.58%
950.47	5.90E-04	65.54%
970.52	5.33E-04	65.48%
990.57	4.00E-04	65.43%
1010.62	6.72E-04	65.38%
1030.67	2.35E-04	65.34%
1060.72	3.39E-04	65.30%
1100.77	1.70E-04	65.25%
1140.82	1.40E-04	65.21%
1180.87	1.52E-04	65.19%
1230.92	3.77E-05	65.16%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3L	
Instruments:	VTS#03/GCMSD	
Date/Experiment #:	08/29/06	23
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	9 µL	
Mass of agent disseminated:	9.09 mg	
Corrected mass on 100% agent purity:	8.27 mg	
Average substrate temperature:	50.69 °C	
Average air flow rate:	405.41 SLPM	
Average air temperature above drop:	50.32 °C	
CCVs within criteria:	No	
Mass % recovery by extraction:	n/a %	
Total agent % mass recovery:	25.2 %	
Mass % recovery in vapor:	25.2 %	Raw evaporation rate: 0.0040 mg/min
Tube #s consistant:	Yes	
Comments:	1 of 3 ccvs outside current criteria	

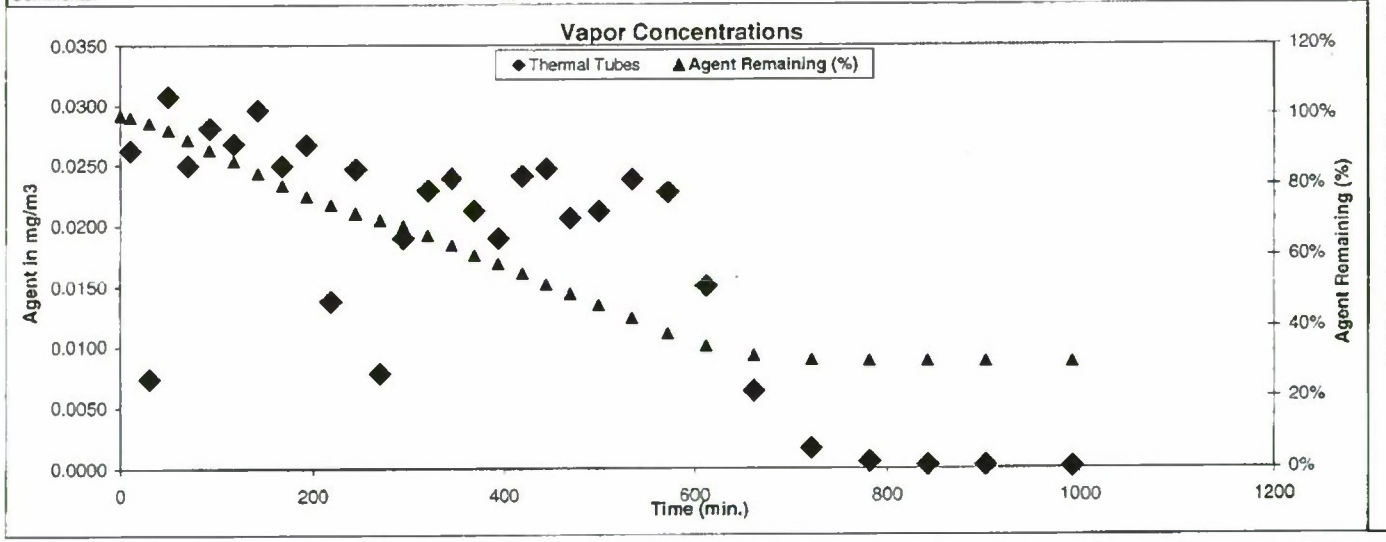


Time (min)	Conc. mg/m³	Agent rem. (%)
10.72	1.07E-02	99.72%
39.10	1.37E-02	98.03%
67.48	1.08E-02	96.33%
95.87	1.04E-02	94.86%
124.23	1.05E-02	93.41%
152.62	9.10E-03	92.05%
181.00	9.63E-03	90.74%
209.38	8.18E-03	89.51%
237.77	7.87E-03	88.39%
266.15	7.41E-03	87.33%
294.53	1.63E-02	85.68%
322.92	8.24E-03	83.97%
351.30	7.58E-03	82.87%
379.68	7.66E-03	81.81%
408.07	1.14E-02	80.48%
436.47	7.91E-03	79.13%
464.85	6.32E-03	78.14%
498.23	4.84E-03	77.23%
536.62	3.84E-03	76.41%
566.67	3.00E-03	75.91%
596.70	1.73E-03	75.56%
631.75	6.51E-04	75.36%
671.80	5.79E-04	75.24%
721.85	3.60E-04	75.12%
781.90	2.43E-04	75.03%
841.95	2.41E-04	74.96%
902.00	1.68E-04	74.90%
962.05	1.40E-04	74.86%
1022.10	9.45E-05	74.82%
1082.15	1.45E-05	74.81%

Data Evaluation Grade: **Modeling Grade**

Tunnel:	3L	
Instruments:	VTS#03/GCMSD	
Date/Experiment #:	09/06/06	25
Type of substrate :	Glass	
Test agent/purity:	VX_CASARM	
Number of drops:	1	
Nominal drop volume:	9	µL
Mass of agent disseminated:	9.09	mg
Corrected mass on 100% agent purity:	8.27	mg
Average substrate temperature:	50.63	°C
Average air flow rate:	405.46	SLPM
Average air temperature above drop:	50.28	°C
CCVs within criteria:	Yes	
Mass % recovery by extraction:	n/a	%
Total agent % mass recovery:	70.1	%
Mass % recovery in vapor:	70.1	%
Tube #s consistant:	Yes	
Comments:	n/a	

Raw evaporation rate: 0.0089 mg/min



Time (min)	Conc. mg/m³	Agent rem. (%)
10.72	2.63E-02	99.31%
30.77	7.37E-03	97.66%
50.82	3.07E-02	95.79%
70.87	2.50E-02	93.05%
93.42	2.81E-02	90.12%
118.47	2.68E-02	86.75%
143.52	2.95E-02	83.29%
168.57	2.49E-02	79.95%
193.62	2.67E-02	76.78%
218.65	1.38E-02	74.30%
243.70	2.46E-02	71.94%
268.75	7.79E-03	69.95%
293.82	1.89E-02	68.31%
318.87	2.29E-02	65.74%
343.92	2.39E-02	62.87%
368.97	2.12E-02	60.11%
394.02	1.89E-02	57.65%
419.07	2.41E-02	55.01%
444.12	2.47E-02	52.02%
469.17	2.06E-02	49.24%
499.22	2.12E-02	46.16%
534.27	2.38E-02	42.30%
571.82	2.27E-02	38.02%
611.87	1.50E-02	34.31%
661.92	6.32E-03	31.69%
721.97	1.61E-03	30.53%
782.02	5.45E-04	30.21%
842.07	2.77E-04	30.09%
902.12	2.47E-04	30.01%
992.17	1.25E-04	29.93%